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THE ROENTGEN VISUALIZATION AND DIAGNOSIS OF BREAST LESIONS BY MEANS OF CONTRAST MEDIA*

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THE utilization of radiopaque substances in the roentgenographic visualization of the kidney, the brain and the gastrointestinal tract has transformed the diagnosis of lesions of these organs into an exact science. Correct diagnosis has replaced clinical supposition. Unfortunately our ability to recognize many pathological conditions of the breast during their early development is far from satisfactory. If neoplasms are to be detected while they are still small, and hence curable, some method of visualizing the entire mammary gland would be most helpful.

The first attempt to visualize the breast was made by Salomon[24] in 1913 when he tried to correlate the anatomic, pathologic and roentgenographic findings of malignant mammary neoplasms. All of his studies were confined to excised specimens. In 1929, two interesting reports appeared, one by Goynes, Gentil and Guedes,[8] in which they maintained that the roentgenographic differentiation of breast tumors was possible, and the other by Ries[23] who reported an "unusual breast abscess following the introduction of diagnostic lipiodol into the milk ducts." Some unnamed physician had attempted to visualize a papillomatous tumor by introducing lipiodol into the bleeding duct. An accurate roentgenographic pattern of the dilated lactiferous tubules was obtained but the tumor was not seen. The resulting abscesses caused Ries to condemn the procedure as too hazardous. It was not until the work of Warren[26] in 1930 that the possibilities of roentgenologic studies of the breast were fully appreciated. Later, Paschette,[21] Seabold,[25] Fray and Warren[6] and particularly Lockwood[16] convincingly demonstrated the effectiveness of stereoscopic roentgenograms in depicting mammary neoplasms. In 1933, Baraldi[1] suggested the utilization of contrast gases as a means of enhancing the visibility of breast tumors, and in 1935 his confrère, Benzadón,[4] described the technique for making these "pneumographic studies."

During the past two years, we have developed a method of diagnosing the various types of mammary neoplasms roentgenologically by means of contrast media.[9] This can be accomplished in one of two ways.

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FIG. 1. Cannulization of the milk ducts with a No. 27 Hicken breast cannula.

The first is to inject the milk ducts with some radiopaque substance and then make stereoscopic studies. The resulting "mammograms" present accurate anatomical patterns of the injected ducts. Any pathological condition which alters their size, shape or conformation is readily detected. In the second procedure,[10] termed "aeromammography, CO_2 is injected into the retromammary and premammary spaces in such a manner that the diffusing gas forms a contrast capsule around the parenchymal tissue and reveals any neoplasms contained therein. Contrast mammographic studies should be used when the simple roentgenograms are not informative as they graphically portray the refined differentiation of anatomic relations and pathologic processes.

TECHNIQUE

Mammography. The technique for injecting the radiopaque material into the lactiferous ducts is very simple. The breast is thoroughly cleansed as for any surgical procedure and only sterile instruments and solutions are used. Hot moist compresses are applied to each nipple for at least fifteen minutes. The moisture softens any plugs of inspissated material which may be occluding the ducts and the heat relaxes their sphincters. A gentle stripping massage of the nipple will then express a few drops of secretion to establish the orifices of the milk ducts which are cannulized with a specially constructed needle (Fig. 1).* If properly inserted, the cannula will slide back and forth in the duct for a distance of 1 cm. without causing pain, but if it pierces the duct wall, the slightest manipulation becomes very annoying.

Occasionally some difficulty is encountered in locating the orifices. This is particularly prone to occur if the nipples are inverted, if the breasts are obese, or if they have never lactated. In such instances no secretion can be expressed from the nipple and the ductal orifices cannot be seen. No attempt should be made to cannulize lacteals which are not patent since forcing the contrast solution into a collapsed duct invariably results in periductal extravasation. Magnifying lenses are of no value in locating the openings of the ducts. Frequently the sphincter which guards the orifice will be thrown into a spastic contraction by the blunt cannula and the lumen will appear to be occluded. This physiological obstruction can be overcome by resting the cannula lightly against the sphincter so that when the muscle becomes momentarily fatigued and relaxes, it will slip easily into the duct.

Only very slight pressure is required to introduce from 0.5 to 2 cc. of the contrast substance into each duct, the amount varying according to the size and functional status of the breast. Usually one can feel the distention as the solution enters, and the injection is continued until the patient experiences a mild sense of discomfort which radiates from the nipple to the periphery of the injected lobule. Sharp severe pains are warning signals, indicating that the fluid is

* Hicken breast cannula made by Becton, Dickinson and Company.

entering the periductal tissues, either from over-distention and rupture of the smaller lacteals or from penetration of the duct wall by the cannula. Experience readily eliminates both of these errors.

It is better to study the tumor-bearing lobule first so that there will be no superimposition of shadows from adjacent segments. If the tumor is in the upper outer quadrant of the breast, the duct which drains this segment will occupy a corresponding position on the nipple. If one of the ducts is discharging, it should be studied first. Usually the entire breast can be visualized by injecting from six to eight of the larger ducts. Any existing lesion will leave identifying marks on these structures.

After stereoroentgenographic studies have been made, the contrast solution is removed from the ducts with a breast pump, supplemented by milking-massage of the nipple. At times a gentle saline lavage of the ducts will expedite their evacuation.

Midmammary Cysts. Much information concerning the size, shape and location of retention cysts can be obtained from mammograms as the expanding tumors produce recognizable deformities by displacing the regional lacteals. Such studies, however, yield no information concerning the pathological changes within the cyst itself. Complete visualization can be accomplished by introducing the contrast medium directly into the cystic cavity (Fig. 19). An exploring needle is plunged into the tumor mass and, if cystic, its contents are aspirated and replaced by an equal volume of air. Stereoscopic roentgenograms give a distinct reproduction of the inflated cyst, outlining its walls, revealing any papilliferous extensions into its cavity, and demonstrating multilocular pockets or communicating cysts. Following this the air is aspirated and replaced by thorotrast which sharply outlines the limits of the cyst and any communication with regional ducts. After the mammograms are taken, the thorotrast is evacuated and the cystic cavity is thoroughly cleaned with saline solution. It is very important that the exploring needle be left in situ during the studies as it prevents the extravasation of the medium and also obviates the necessity of repeated punctures.

Fig. 2. Apparatus devised for CO_2 insufflations of the breast.

Aeromammograms. The utilization of CO_2 as a constrasting gas affords an excellent means of studying mammary neoplasms, providing the gas can be made to surround the growing tumor. A simple but effective apparatus has been devised to facilitate the studies.[10] A small tank of CO_2, a reducing valve to control the gas pressure, a flask of sterile water, a rubber tubing, and a sharp 20-gauge needle are arranged as in Figure 2. The CO_2 escapes from the cylinder under slight pressure, bubbles through the sterile water and escapes from the injecting needle. Asepsis is essential to prevent infection. The breast is grasped with the examiner's left hand and lifted from the chest wall. This permits the needle to be inserted into the retromammary space so that its point lies anterior to the pectoral muscles (Fig. 3*A*).

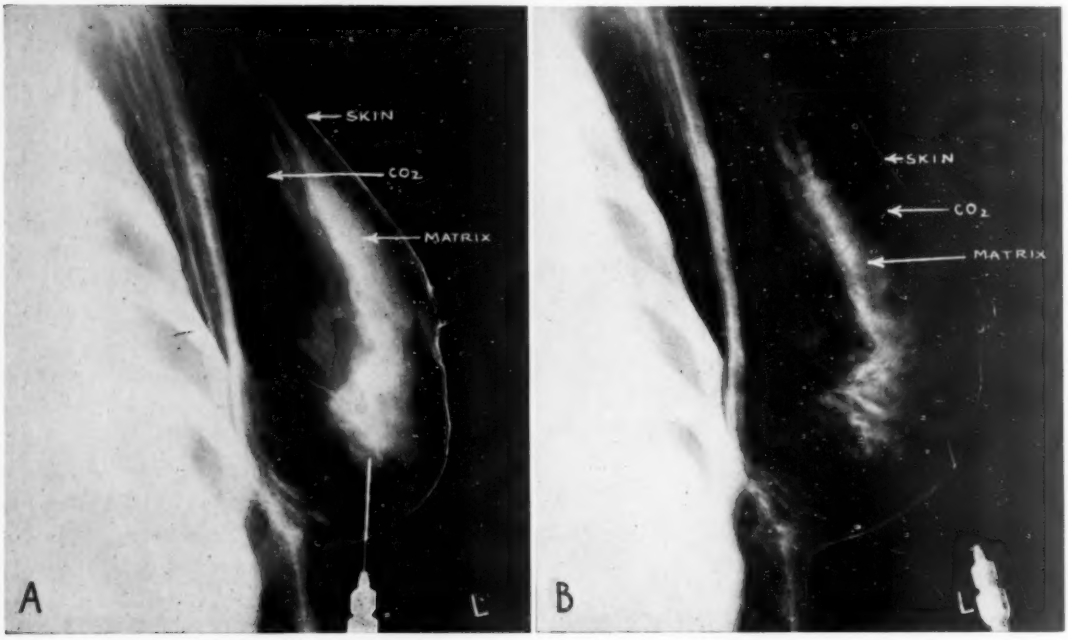

FIG. 3. The retromammary, *A*, and the premammary, *B*, spaces are inflated with CO_2 until the gas completely surrounds the matrix tissue.

When the CO_2 is introduced it rapidly separates the breast from its muscular bed, elevating it from the chest wall and at the same time distending the gland until it resembles an inflated balloon. No definite rule can be given for the rate of injection or the amount of gas to be used, as they both vary according to the size and texture of the gland. When the retromammary space has been properly inflated the CO_2 will begin to follow the regional fascial planes into the supraclavicular area and down along the lateral thoracic muscles. As soon as this is observed the needle is quickly withdrawn and re-inserted into the premammary subcutaneous tissues (Fig. 3*B*). The CO_2 rapidly diffuses and separates the skin from the underlying matrix. The true mammary tissues are thus surrounded by a contrast capsule of gas which greatly enhances its visualization. If correctly inflated the breast should be two or three times larger than its uninjected mate. It is imperative that stereoscopic roentgenograms be taken immediately for a delay of two or three minutes is sufficient to permit a partial absorption of CO_2 which results in unsatisfactory mammograms.

Contrast Media. To be satisfactory, the contrast medium must possess certain essential qualities. First, it must be non-irritating; second, it must be either a labile fluid or a gas which can readily enter the smaller lacteals and acini; third, it must possess such a high degree of radiopacity that even a minute amount will produce a sharply delineated shadow; and last, it must be absorbable or must be eliminated from the ducts. Clinical and laboratory experiments with stabilized thorium dioxide sol (Heyden), lipoiodine (Ciba), lipiodol (Lafay), diodrast (Winthrop), hippuran (Mallinckrodt), 15 per cent sodium iodide, bismuth oxychloride (Mallinckrodt), air, nitrogen, oxygen and CO_2 can be summed up as follows:

Thorotrast (Heyden) is a 25 per cent solution of stabilized thorium dioxide in a colloidal dispersion. It has proved to be the most satisfactory medium for visualization of the milk ducts. That it is non-irritating to tissues is evidenced by its extensive use in cholangiography,[15] hepatography, and

arteriography without clinical evidence of local or constitutional damage. In more than 300 breast injections, only 3 abscesses have occurred and they were caused by inadvertently introducing the solution into the periductal tissues. Thorotrast is very labile and has high radiodensity which permits a clear visualization of even the most minute lacteals. Being a colloidal solution, the thorium salt cannot penetrate the duct wall and therefore is not absorbed by either the blood stream or the lymphatics, and it can be removed effectively by an aspirating pump. Figure 4 demonstrates the small amount of residual thorotrast after aspiration of the ducts.

There has been considerable discussion in the literature regarding the possible effects of thorotrast when administered intravenously, because of its radioactive nature. As the thorium dioxide is absorbed and retained by the reticulo-endothelial cells, there has been some question as to the biological effect of continued exposure of these tissues to small amounts of this radioactive substance. There are several valid reasons why no deleterious effects have thus far been observed when thorium dioxide has been employed as the mammographic agent. First, only small amounts, usually 1 to 10 cc., are required for complete visualization of the breast as compared with 75 to 100 cc. for visualization of the liver, spleen or vascular system. Second, thorotrast is introduced into a closed system of ducts which are normally excretory in function and are not lined with reticulo-endothelial cells to fix the substance. Hence, it escapes spontaneously from the ducts, leaving only a small residue (Figs. 30 and 31). Saline lavages supplemented by cleansing aspirations will effectively remove the greater part of the injected thorotrast. The residue is so minute that its radioactive influence would be negligible. Fourth, thorotrast has not been

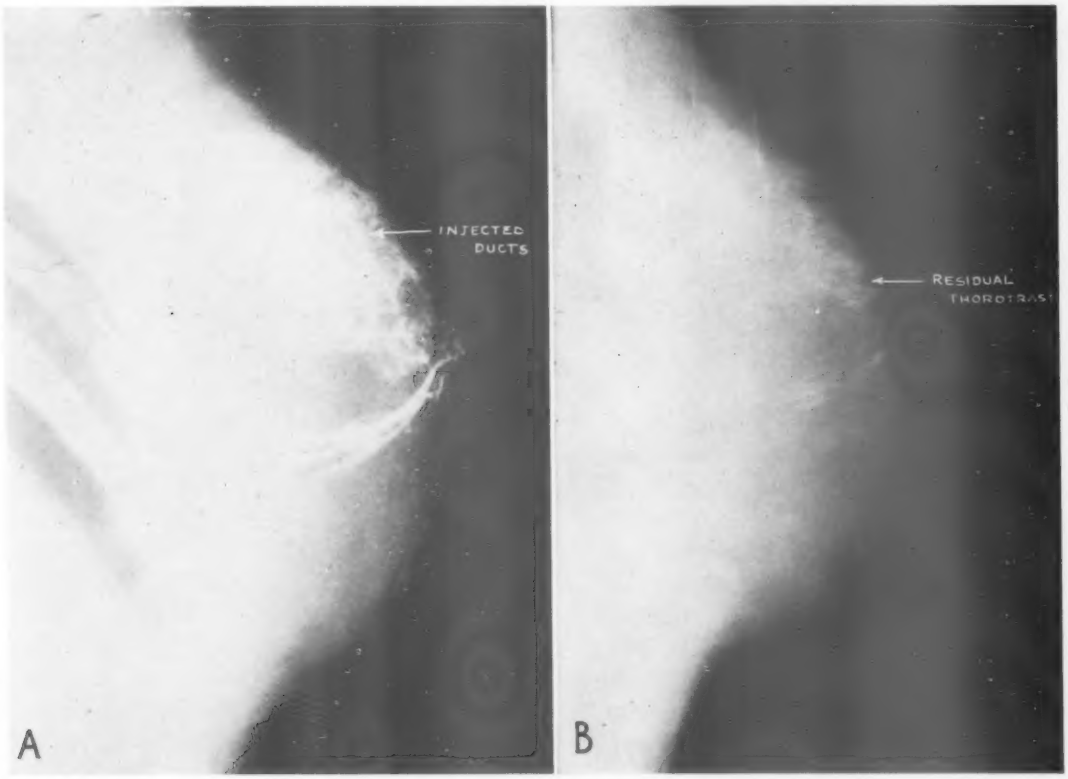

FIG. 4. Two lobules of a lactating breast were injected with 4 cc. of thorotrast, *A*. After applying the breast pump only a faint tract of thorotrast remained, *B*.

irritative to the mammary tissues for it has remained in the ducts for a period of two years without producing harmful biological effects. These were our earlier cases in which no cleansing aspirations were attempted. Lactating breasts have continued to function without any evidence of mastitis or decreased milk production.

While thorotrast is the most suitable mammographic agent which we have at that they cannot be forced through the small cannula, nor will they flow into the tiny lacteals and acini. If an attempt is made to force the oil into the lactiferous radicals, so much pressure is required that the thin-walled ducts are ruptured. Dilution with less viscid oils impairs its roentgenographic density. The chief objection to these iodized oils, however, is that they cannot be evacuated from the ducts and

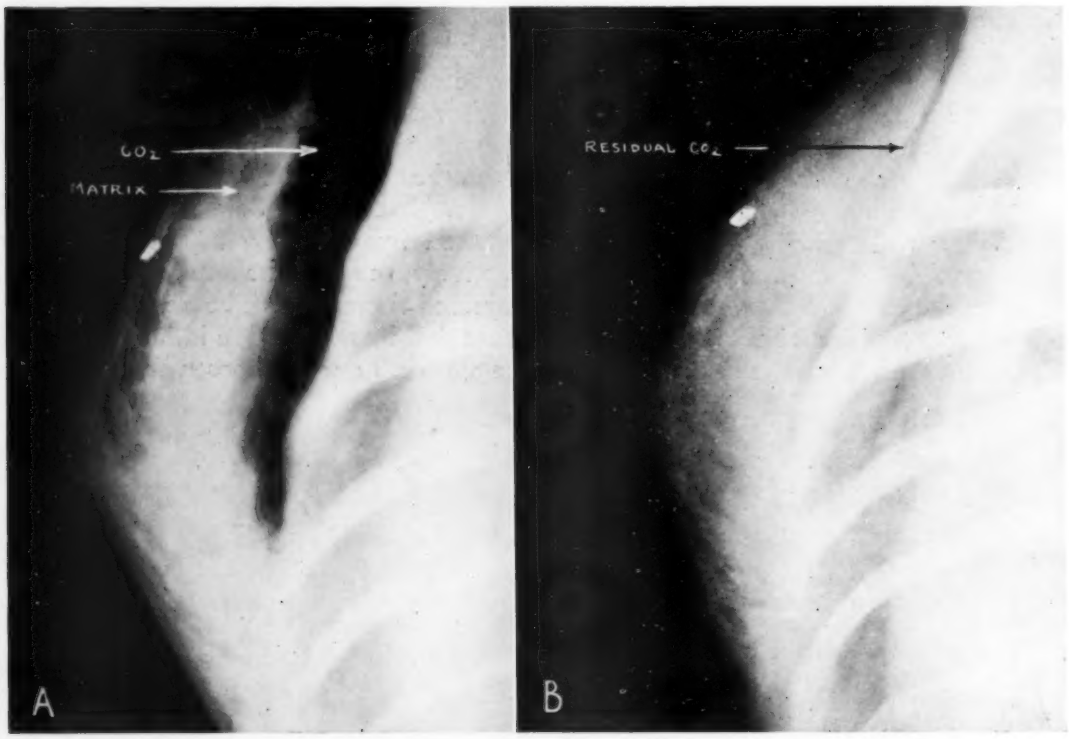

FIG. 5. *A*. Breast inflated with CO_2. *B*. Complete absorption of CO_2 fifteen minutes later.

the present time, it should be employed with caution until its biological reactions have been accurately determined. Every attempt should be made to remove it from the ducts when the studies are completed. It is imperative that only the stabilized thorium dioxide preparations be used, for the unstable solutions such as umbrathor (Heyden) may flocculate, in which event it could not be removed from the ducts.

Iodide Preparations. Various types of iodized oils have been used but they all have definite disadvantages. Lipoiodine (Ciba) and lipiodol (Lafay) are so viscid consequently sometimes cause considerable reaction of the tissues. Ries[23] reports a case in which lipiodol produced a breast abscess seven weeks after the primary injection.

Hippuran (Mallinckrodt) and diodrast (Winthrop) are soluble organic iodides and have been used extensively for oral and intravenous urography, but their low roentgenographic density combined with their great diffusibility makes them undesirable mammographic agents. When introduced into the ducts, they diffuse so rapidly into the periductal tissue that a pattern of the lacteals cannot be obtained. Various con-

centrations of sodium iodide have been used but they are so irritating and evoke such an intense mastalgia that they have been abandoned.

Bismuth oxychloride possesses great radiopacity and gives a very distinct pattern of the injected ducts. Unfortunately, however, it is such a heavy suspension that the solid ingredients settle in the smaller lacteals and completely block their lumina. Attempts to remove it have always failed. Therefore, it should be used only in studying excised or necropsy specimens.

Gases. All gases are excellent foils when injected into the breast tissue but unfortunately some of them provoke undesirable sequelae which preclude their use. Filtered air is an excellent medium for it gives a distinct outline of the breast parenchyma. Its chief disadvantage is the attendant emphysema which sometimes persists for ten to fourteen days. During this interval the patient experiences considerable discomfort and finds it necessary to restrict her work. Nitrogen is absorbed so slowly by the tissues that it is not a suitable agent. Following the suggestion of Baraldi[2,3] and Benzadón,[4] oxygen has also been used, and while it is absorbed much more readily than either air or nitrogen, it still produces an annoying mastalgia during the first twenty-four hours.

Continued experiments have demonstrated that CO_2 is the ideal visualizing agent.[10] It is not irritating to tissues, it produces a well-defined outline of the breast structures and, most important, it is completely absorbed within fifteen minutes after its introduction (Fig. 5). Its rapid absorbability eliminates the danger of CO_2 embolism even though it should be accidentally introduced into the blood stream.

By using an aseptic technique, no undesirable sequelae have developed in a series of more than 150 CO_2 insufflations. Patients readily submit to repeated studies because the discomfort is but momentary.

Roentgenographic Technique. Because of its anatomic accessibility, excellent roentgenographic projections of the mammary gland can be obtained with a minimum of distortion, and very little superimposition of other structures. The patient is placed in a lateral recumbent position with the injected breast supported by a 17 or 23° angle board (Fig. 6). This device holds the breast away from the chest wall and permits the film to be placed in close apposition to the gland, thus minimizing distortion. Good roentgenograms can likewise be obtained by using a Seabold cradle,[23] a Lockwood balloon,[17] or by placing the patient in the Gershon-Cohen[7] position.

Fig. 6. The lateral recumbent position and the use of an angle board give undistorted roentgenograms of the breast.

The arm on the affected side is held in abduction or is placed behind the head, and the free hand retracts the opposite breast from the roentgenographic field. The film must be placed so as to include the entire mammary gland and the axilla. It is important that the central rays strike the breast in an exactly transverse direction in

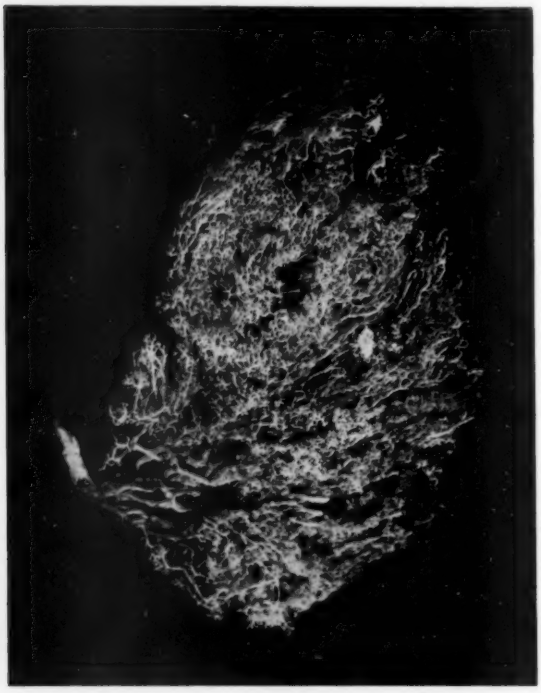

FIG. 7. A corrosive moulage of the ductal system of a quiescent multiparous breast.

order to avoid superimposition of costal shadows. Posteroanterior and special projections tangential to the underlying thoracic wall frequently give additional information but they are used only in problem cases. Cardboard holders give better soft tissue details than do the screens except in ponderous breasts. All roentgenograms are taken at a distance of 75 cm., with the machine regulated to deliver 45 to 60 kv. (peak) at 45–50 ma. for a period of one to three seconds. The penetration and time are varied according to the size and texture of the breast. The profile of the gland can be accentuated by applying lead carbonate paste to the skin. When employing CO_2 insufflations it is expedient to place the patient in the proper roentgenographic position before beginning the inflation or the aeromammograms will be unsatisfactory.

INTERPRETATION

Normal. A normal well-developed mammary gland consists of fifteen to twenty pyramidal lobules containing secreting glands, collecting tubules, and matrix tissue. The base of each pyramid rests on the pectoral muscles and the apex points toward the nipple. The acini and smaller lacteals are situated deep within the stroma, the latter converging to form the large ampulla which opens on the surface of the nipple (Fig. 7). The fibrous tissue trabeculae and the lacteals form characteristic striations which radiate toward and converge at the nipple. According to Lockwood,[18] there are four zones of the breast which

FIG. 8. Virginal breast. A retouched mammogram showing the ramifying lacteals. The ducts are small, the ampullae are not dilated and the acini are not developed.

should be visualized by soft tissue roentgenograms: the skin, the translucent premammary subcutaneous tissues, the dense matrix with its characteristic striations, and the retroglandular zone of fatty tissue. Unfortunately, these patterns are so greatly modified by obesity, menstruation, lactation, and senile involution that many roentgenologists find interpretation difficult and indefinite. Contrast visualiza-

tions, however, so accentuate the ductal patterns and intensify the normal breast markings that any gross abnormality can be readily detected.

Virginal Breast. In the virginal breast, active function has not developed the acinar and ductal tissues. The lobules are small, the linear striations appear as thin indistinct lines, the matrix tissue is irregular, mottled and semi-opaque, and there is usually a large amount of adipose tissue in the premammary and retroglandular spaces. If the ducts are distended with contrast material they appear as fine white threads which penetrate the matrix tissue and form a dense network of ramifying tubules (Fig. 8). The ampullae are not dilated and the acini are not visible for these structures do not become fully developed until lactation occurs. The uniform manner in which the ducts ramify the stroma denies the possibility of neoplastic distortion.

In the aeromammogram, the outline of the matrix is intensified by the contrast with the surrounding CO_2. The inflated premammary and retroglandular zones are clearly visible and the lactiferous ducts and fibrous tissue septa are more distinctly outlined than in an ordinary soft tissue roentgenogram (Fig. 9).

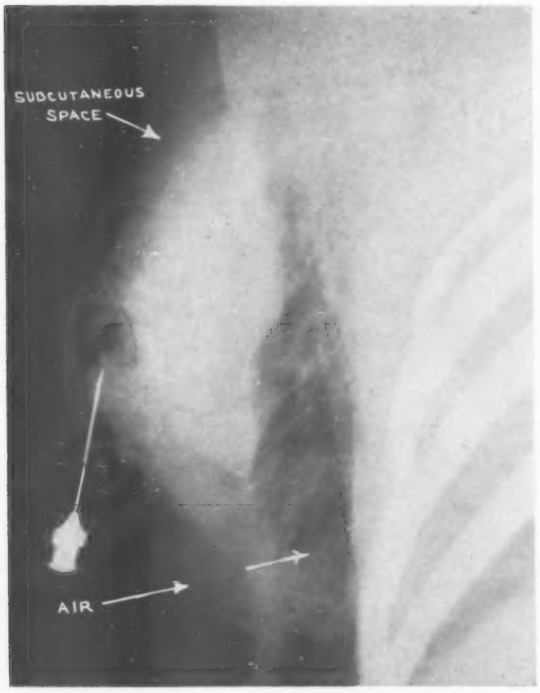

Fig. 9. CO_2 insufflations enhance the visualization of the matrix. The striations of the virginal breast are very fine.

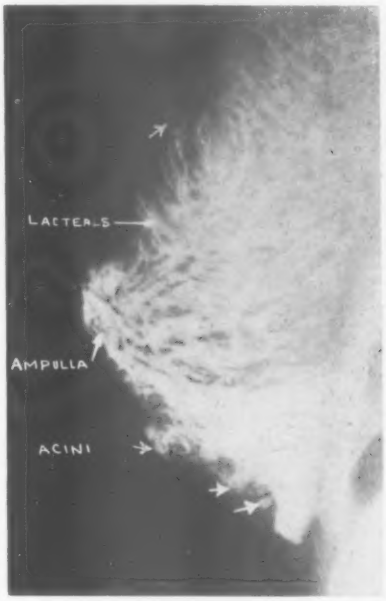

Fig. 10. Lactating breast. Mammogram on third post-partum day shows hypertrophied ducts, dilated ampullae, and fuzzy caps (acini) on the ends of the terminal lacteals.

Lactating Breasts. There is considerable variation in the appearance of lactating breasts, depending on their size, the number of lactations experienced and the amount of milk which they produce.[9] Active function produces a definite hypertrophy and hyperplasia of the secretory and ductal system. The striations are much larger, the amount of adipose tissue is relatively reduced and the glandular structures become more dense. The ducts are larger, they are more numerous, their ampullae are widely dilated and the acini appear as tiny tufts or caps on the ends of the terminal lacteals (Fig. 10). The CO_2 insufflation demonstrates a marked hyperplasia of the matrix tissue and rarefied fatty tissue areas can be seen on all sides of the larger ducts.

Multiparous Breast. The multiparous breast has definite characteristics. The ductal and fibrous tissue striae are usually broader and more distinct than in the virginal or primiparous gland. The stroma appears more dense and there is less adi-

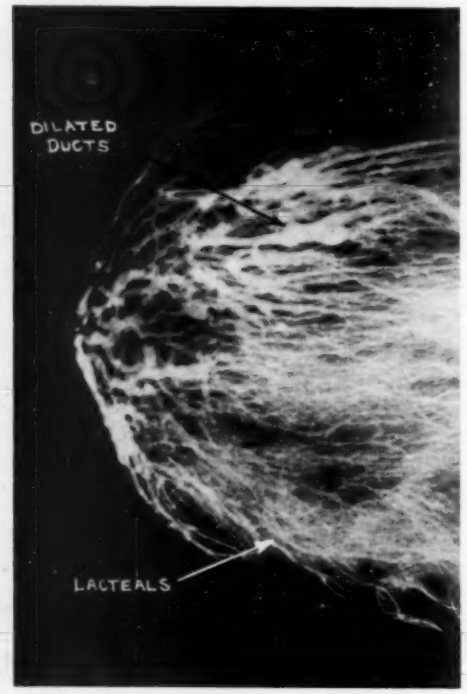

FIG. 11. Ducts of multiparous breast were injected with lipoiodine. The large dilated ducts and the dense network of large lacteals indicate a "good milk producer."

pose tissue. The subareolar ducts are distinctly visible. In the mammograms, the ducts appear dilated, the ampullae are particularly large and the matrix consists of a network of branching lacteals. The acini are not visible in the quiescent breast which differentiates it from the lactating organ (Fig. 11). In those mammary glands which have produced large quantities of of milk, the ducts are larger than in the poorly secreting breast (Fig. 12). If the gland is obese, the fatty tissue produces a concentric pressure on the ducts, thus decreasing their lumina to mere filaments. The adipose tissue gives the matrix a mottled appearance because the localized deposits of fat are radiolucent.

Although there is some individual variation in the size, shape and functional appearances of the normal gland, the component tissues present a certain basic pattern. In this respect the breast is akin to the kidney for not all renal pelves have the same conformation and yet one is able to differentiate between normal and pathological organs by means of pyelograms. Disease produces characteristic changes in the breast pattern by displacing, obstructing, invading or destroying the lactiferous ducts. The ability to visualize such deformities is the basis of mammographic diagnosis.

Papilloma. Patients who complain of a bloody discharge from the nipple present a tantalizing diagnostic problem. Is the

FIG. 12. Multiparous breast injected with thorotrast. The small lacteals indicate a poorly functioning gland. No disturbance in the normal distribution of the ducts.

bleeding due to an intraductal carcinoma, sarcoma, papilloma, hemorrhagic cyst, acute intraductal infection, or trauma?[14] All too frequently, physical examination fails to demonstrate the etiological factor.

Even transillumination, as introduced by Cutler,[5] usually fails to locate the offending papilloma unless it is surrounded by an intraductal hematoma. In such an event, it is the clotted blood which casts the shadow and not the tumor itself. Lockwood and Stewart[20] state that papillomatous tumors cannot be revealed by soft tissue roentgenograms because they possess the same radiolucency as the surrounding stroma.

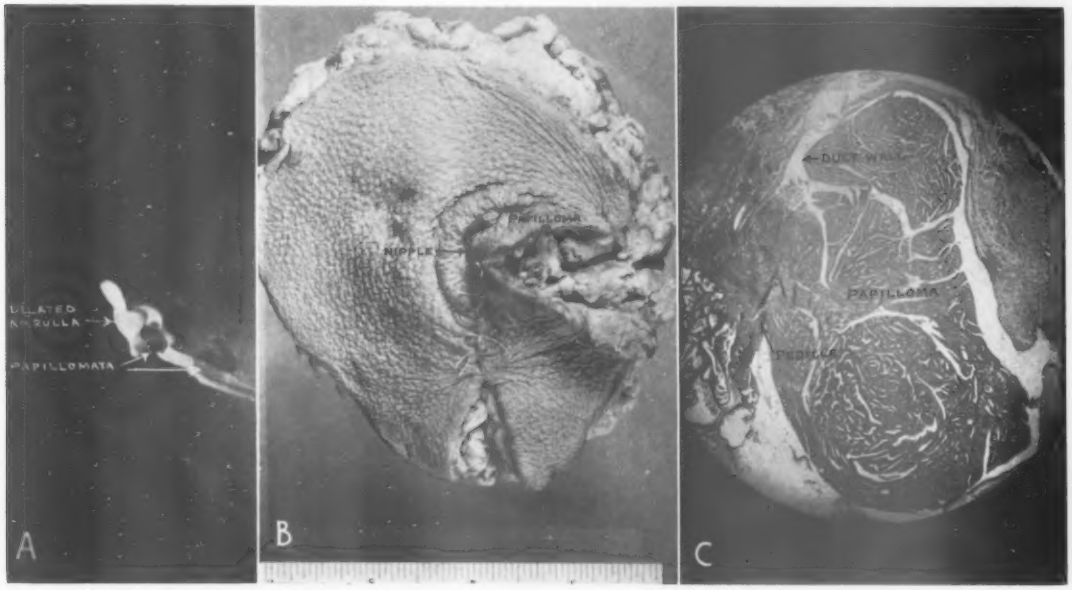

Fig. 13. *A.* The bleeding duct was injected with thorotrast. Note the two "filling defects" indicative of a ductal papilloma. *B.* Gross specimen shows the duct containing the two papillomas. *C.* Photomicrograph confirms the diagnosis of intracystic papilloma.

Fortunately, however, these troublesome neoplasms can be accurately located and diagnosed by mammograms.[13] The bleeding duct is cannulized and injected with thorotrast following which immediate stereoscopic roentgenograms are made. Since these papilliferous growths protrude into the lumina of the parental ducts or cysts, they displace the contrast substance and produce characteristic "filling defects" which are very apparent (Figs. 13, 14, and 15). They usually occur singly and are located in the ampullic segment of the subareolar ducts, but occasionally they may be multiple or bilateral. It has been our practice to study both breasts and in 2 instances we have visualized large papillomatous tumors in the asymptomatic, apparently normal breast. This would indicate that papillomas occur more frequently than we appreciate, and the absence of symptoms and physical findings is no assurance that such tumors are not present.

Being able to locate and to determine the number of papillomas present aids the surgeon in selecting the proper operative procedure. Roentgenoscopy of the injected breast permits the radiologist to accurately plot the extent of the diseased lobule so that a segmental resection can be done. If the tumors are multiple, simple excision is abandoned in favor of a mastectomy. During the past ten months we have been able to diagnose 6 cases of papillomatous tumors by mammographic studies. In one instance they were bilateral, in another there were multiple papillomas in the same segment, and in 2 cases the largest tumors were found in the asymptomatic breasts.

Cystic Disease of the Breast. The recognition and proper evaluation of mammary cysts is difficult. Cysts may represent a

simple physiological change, as in mazoplasia; or a benign degenerative transition as chronic desquamative epithelial hyperplasia. They may develop as retention cysts, thus forming galactoceles and simple blue dome cysts, or they may occur as a

FIG. 14. Papilloma. The bleeding duct would accommodate but 0.25 cc. of thorotrast. The mammogram shows the lumen to be plugged by two intraductal tumors, one of which is obstructing the lumen so that the thorotrast cannot enter the terminal lacteals.

degenerative phase of a rapidly growing carcinoma, sarcoma or papilloma. To consider all cysts as potentially malignant, leads to many unnecessary radical operations; but to clothe them with the mantle of benignancy and adhere to the policy of watchful waiting is often disastrous. Contrast mammograms are very effective in determining the exact nature of these troublesome tumors.

Infected Cyst. Localized desquamation may occur so rapidly in certain parts of the milk ducts as to form definite cysts. These cavrties communicate with the duct, and hence evacuate their seropurulent content through the ductal orifice. At times, the cyst becomes distended and the patient complains of a palpable tumor, but when collapsed the neoplasm defies detection. These so-called "phantom tumors" sorely vex the physician for he is usually unable to find the "lump" which has disturbed his patient. This is particularly true if the breast is large and the woman has a nervous, introspective disposition. Soft tissue roentgenograms invariably fail to locate the evanescent tumor. If, however, thorotrast is introduced into the discharging duct, it will distend the collapsed cyst, making it readily palpable as well as clearly defining its limits roentgenographically

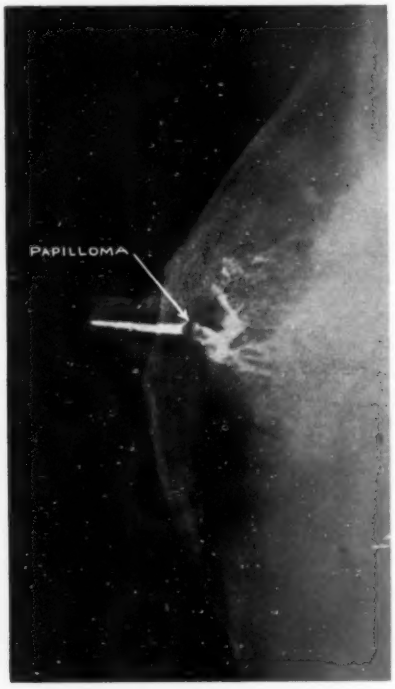

FIG. 15. Retouched mammogram showing the "filling defect" caused by a non-palpable, bleeding, intraductal papilloma.

(Fig. 16). On two occasions "phantom tumors" have been visualized by these studies (Figs. 17 and 18).

Retention Cysts. Sequestrated cysts which have lost their continuity with the regional lacteals frequently become distended with

serous secretion and desquamative products. They are usually situated in the midmammary tissues and are semifluctuant, discrete and movable. They transmit light with great facility and hence appear as rarefied areas. As a rule, the roentgenographic outline of the larger cysts is very indefinite and the smaller cysts are not pictured (Fig. 19*A*). If the regional ducts are injected with thorotrast the mammograms reveal them to be displaced by the expanding cyst because they do not have a patent communication with it (Fig. 19*B*). The normal striations of the breast also circumvent the tumor. An excellent picture of the cystic cavity can be obtained by aspirating the fluid content and replacing it with air or thorotrast (Fig. 19*C*). If there are any papilliferous projections into the lumen of the cyst, if its walls are thickened or indurated, or if it communicates with other cysts or the neighboring ducts, these details will be clearly demonstrated (Fig. 19*D*, *E*). In some instances small, fibrous tissue septa have been seen dividing the large cysts into its component loculi. If the cyst wall appears normal, simple enucleation is curative, but if there are any signs of malignant proliferation, more radical measures must be employed.

Fig. 16

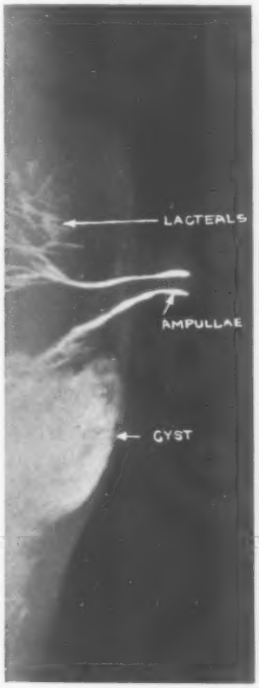

Fig. 17

Fig. 18

Fig. 16. A collapsed midmammary cyst was visualized by distending its discharging duct with thorotrast. Note the extravasation of the solution due to faulty technique.

Fig. 17. A collapsed cyst became visible and palpable by introducing thorotrast into some of the discharging ducts. The upper segment is that of an involuted breast.

Fig. 18. Multiple cystic degeneration of the milk ducts visualized by means of thorotrast.

Galactoceles. These are simple retention cysts which develop in lactating breasts, and differentiation from adenoma, fibroadenoma, lipoma and carcinoma is most difficult. A tightly distended galactocele imparts a feeling of hardness akin to that of a solid tumor and the viscid secretion may absorb so much light that a definite shadow is cast on transillumination. Being retention cysts, these tumors are not re-

duced in size by compression. One hesitates to perform a biopsy as division of the functioning lacteals may result in a seeping fistula.

The true nature of the neoplasm can be easily determined by aspirating its cystic content, which should be composed of thick milk and desquamative products. The interior of the cyst can be studied by inflating it with air. If its walls are smooth and if there is no evidence of papilliferous extension into its cavity, the diagnosis of a benign galactolele is apparent (Fig. 20). Operative intervention can safely be postponed until lactation has subsided.

Mazoplasia. Because of its hormonal regulation, the breast has alternating periods of hyperplasia and regression. In some instances these processes are not well regulated and the patient develops a peculiar form of mastalgia just before each menstrual flow. The breasts become very tender and are usually engorged. No gross abnormalities are demonstrable but soft tissue roentgenograms may be informative. Unfortunately, this syndrome is encountered most commonly in the virginal breast and hence cannot be studied by means of thorotrast injections. CO_2 insufflations, however, greatly intensify the outline of the parenchymal tissue and sometimes reveal existing abnormalities. The stroma

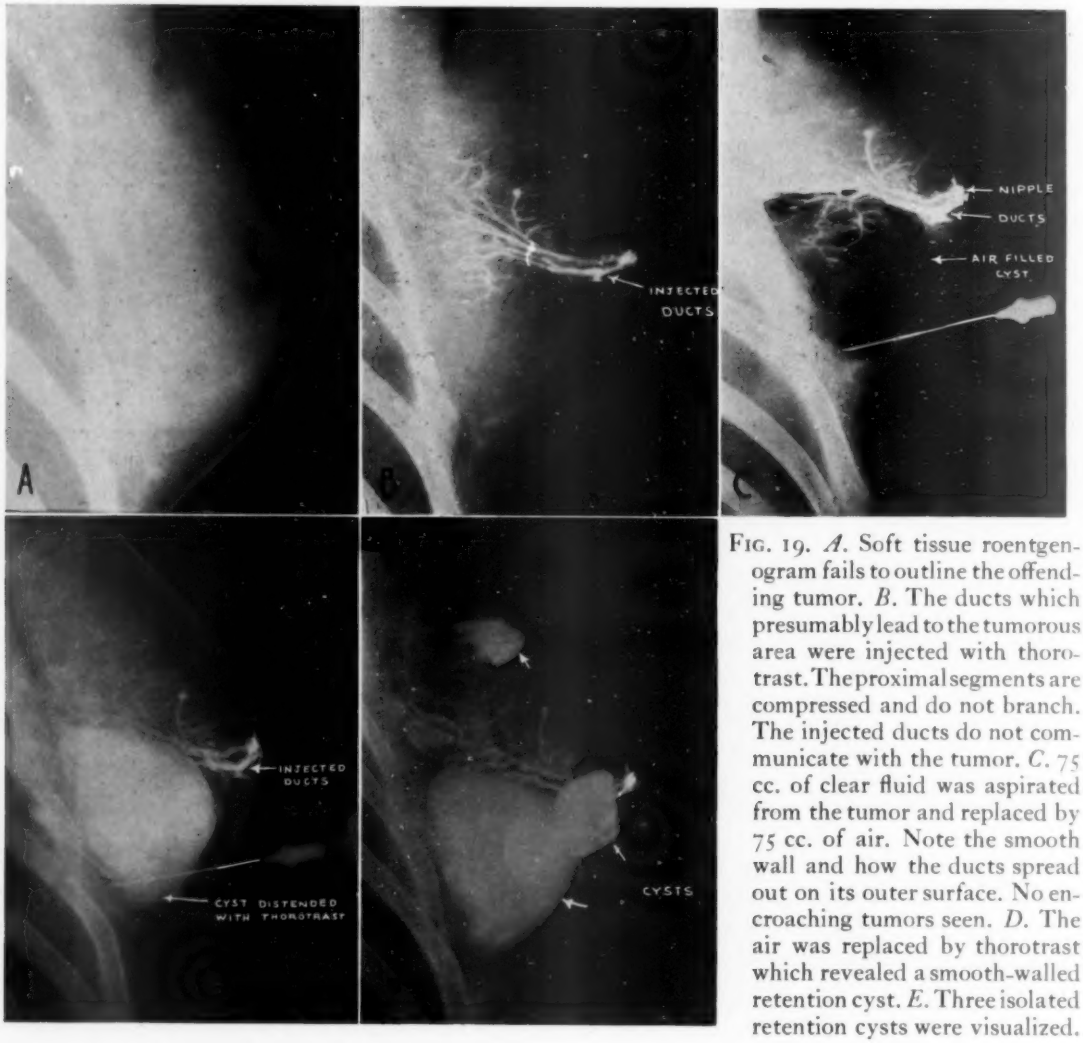

FIG. 19. *A.* Soft tissue roentgenogram fails to outline the offending tumor. *B.* The ducts which presumably lead to the tumorous area were injected with thorotrast. The proximal segments are compressed and do not branch. The injected ducts do not communicate with the tumor. *C.* 75 cc. of clear fluid was aspirated from the tumor and replaced by 75 cc. of air. Note the smooth wall and how the ducts spread out on its outer surface. No encroaching tumors seen. *D.* The air was replaced by thorotrast which revealed a smooth-walled retention cyst. *E.* Three isolated retention cysts were visualized.

usually appears dense and the normal striations pass uninterruptedly from the base of the lobules to the nipple. In the vast majority of cases, no pathological changes can be noted, in which event the aeromammograms furnish excellent evidence with which to dispel any cancerophobia. It has been interesting to observe how frequently these "intolerable pains" will spontaneously disappear once the patient has been convinced she has no "tumor." On the other hand, the CO_2 may demonstrate the matrix to be studded with many small rarefied areas which represent minute cysts (Fig. 21). The mastalgia in such cases is

Fig. 20. Seven and a half cubic centimeters of viscid milk was aspirated from the firm tumor and replaced by 10 cc. of air. Note the smooth-walled retention cyst —galactocele.

due to the distention of these small cavities with desquamative products. Any patient complaining of a painful breast is certainly entitled to mammographic observations before being classed as a neurasthenic. On 5 occasions we have found the so-called "idiopathic mastalgia" to be due to a cystic degeneration of the breast and not to mere introspection or neurosis.

Lipoma. Localized deposits of adipose tissue frequently occur in obese breasts.

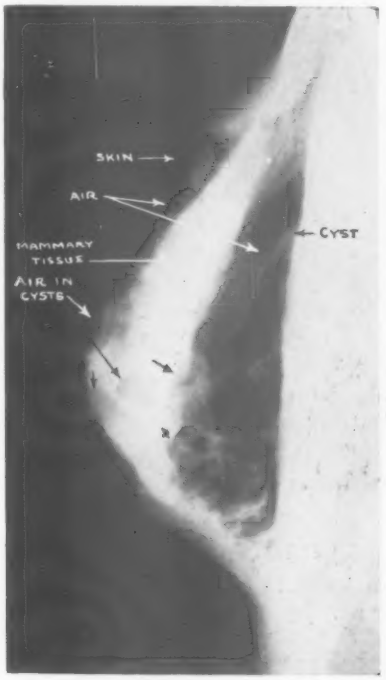

Fig. 21. Mazoplasia. The CO_2 insufflation revealed that the painful breast was studded with multiple small cysts. This breast was thought to be normal on examination.

They are found in the premammary space, in the retroglandular zone and occasionally in the stroma itself. If situated in the subcutaneous area, they are readily identified as soft, encapsulated, movable, translucent masses, but if they are situated within the matrix or in the retromammary space, differentiation is indeed difficult. Because the breasts are large, transillumination is usually not informative. Soft tissue roentgenograms usually show the lipomatous tumor as a compact radiolucent mass, displacing the breast matrix, while other benign neoplasms have a greater radiopacity. Aeromammograms will invariably outline the evasive tumor. Mammography is of no avail because the fatty infiltration of the

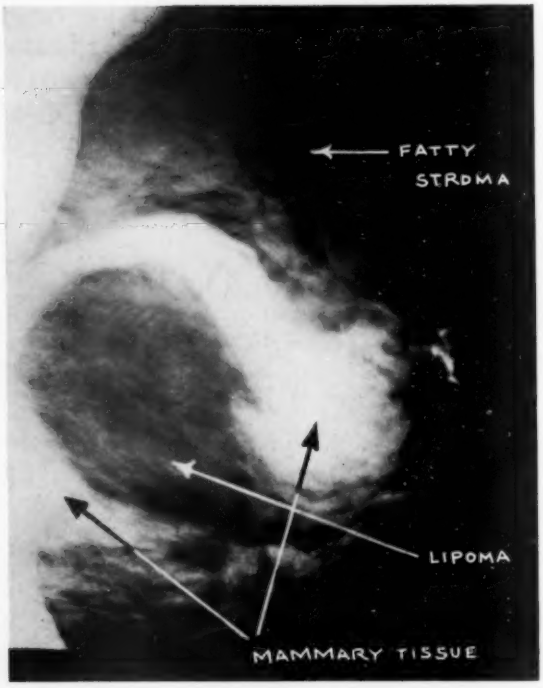

FIG. 22. Lipoma. The white homogeneous matrix is being displaced by a large encapsulated tumor which has the same radiolucency as the fatty tissue stroma.

matrix produces a pressure occlusion of the ducts and the contrast medium cannot be introduced. If properly injected, however, CO_2 will surround the matrix by diffusing into the periglandular spaces. The stroma stands out as a dense homogeneous mass which is being distorted by an encapsulated tumor possessing the same radiolucency as the adipose tissue (Fig. 22). Sometimes the gas will diffuse along the capsule of the neoplasm and clearly outline its circumference. Accurate preoperative diagnosis is thus made possible, and unnecessary biopsies and mastectomies are eliminated.

Fibroadenoma. These are perhaps the most commonly encountered benign solid tumors of the mammary gland. While they appear as indefinite opaque areas on ordinary roentgenograms, they can be accurately visualized by aeromammograms. They project as dense, homogeneous, encapsulated masses which arise from the matrix tissue and have no connection with the skin or muscular structures (Fig. 23). The periphery of the tumor is rather dense and will frequently be separated from its matrix bed by an encircling film of CO_2 (Fig. 24). Occasionally the fibrous tissue will be arranged in whorls. While the regional ducts are usually distorted or displaced by the expanding tumor, there is no interruption in the continuity of the striations and none of them traverse the mass. There is no evidence of invasion of contiguous structures or extension into the axillary space. The tumors, although usually single, may be multiple and are more prone to appear in the breasts of young women. In some instances, a combined mammogram and aeromammogram

FIG. 23. Fibroadenoma. A firm, dense, encapsulated tumor can be seen arising from the matrix following CO_2 insufflations.

proves very informative as it affords a complete visualization of all the mammary structures (Fig. 25).

Malignant Lesions. Lockwood and Stewart[19] have repeatedly emphasized that malignant neoplasms produce characteristic deformities of the mammary gland,

easily recognizable by roentgenographic studies. Because of their destructive nature, these tumors produce definite alterations in the normal architectural configuration of the breast. Unfortunately, however, they possess the same radiodensity as the parent tissue and hence cannot be sharply differentiated from neighboring structures unless contrast mammograms are employed.

If the milk ducts of the tumor-bearing lobule are injected with thorotrast, the true nature of the invading neoplasm can be determined. It must be remembered that benign lesions distort the regional ducts by mechanically displacing or compressing them, but malignant tumors invariably invade, obstruct and destroy these ducts. The neoplastic cells displace the contrast medium and produce a characteristic "beading effect." If the carcinoma has obstructed or destroyed the ducts, the terminal radicals will not be visible and there will be a break in the ductal continuity. Rather than forming a dense mosaic of smooth-walled, regularly branching ducts as in the normal breast, which is used as a control, these malignant processes cause the ducts to appear as a beaded, filamentous cobweb (Fig. 26). In some areas the lacteals are normal and in others they

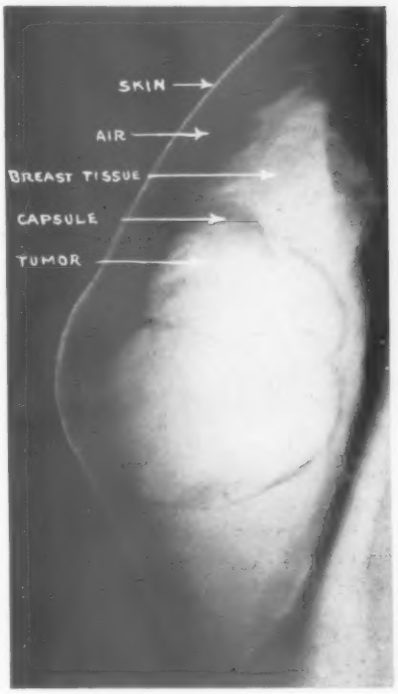

Fig. 24. Shows how the air can outline the capsule of a fibroadenoma.

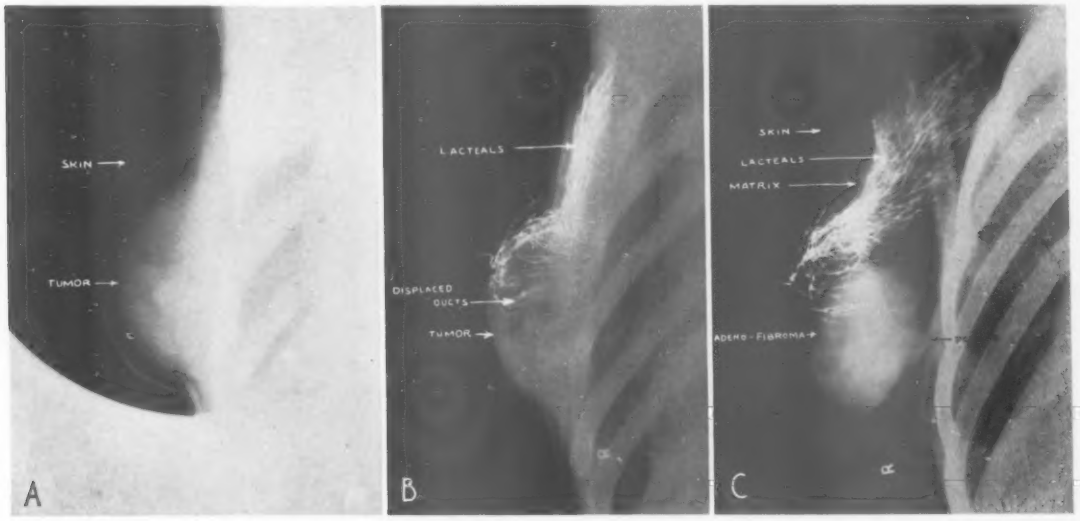

Fig. 25. *A.* Roentgenogram shows a dense well-encapsulated tumor without denoting its origin. *B.* The ducts do not communicate with the tumor but spread over its surface and then ascend into the axilla. Displacement of the ducts indicates benignancy. *C.* Combined thorotrast and CO_2 visualizations reveal the duct-bearing part of the gland to be normal, while a dense encapsulated tumor can be seen arising from the lower matrix. Observe the accessory vascular pedicle attaching the neoplasm to the chest wall.

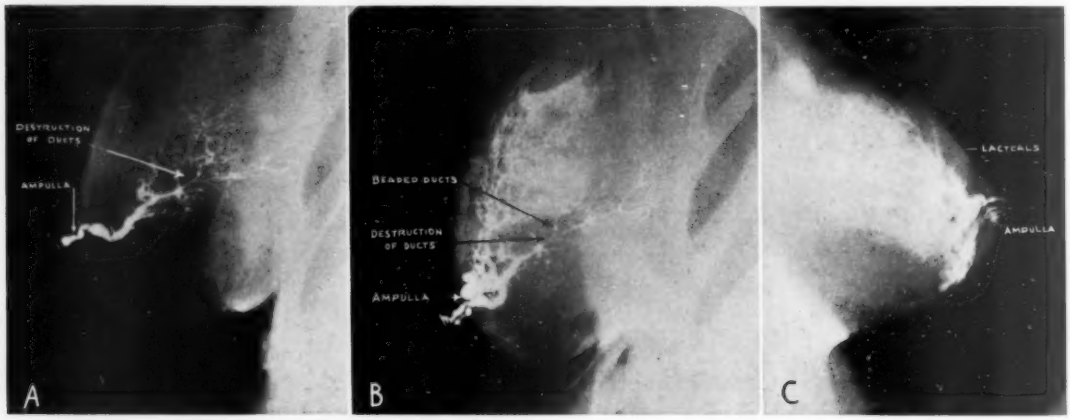

FIG. 26. *A*. One duct injected with thorotrast. Its outer segment is normal but the ramifying lacteals are displaced, invaded and destroyed. Note the "beading effect" due to invasion. *B*. Two ducts were injected with thorotrast and the same destructive invasive process is seen. The ducts appear like a filamentous spiderweb. *C*. Note the dense network of dilated, convoluted, branching ducts which the asymptomatic right breast has as compared with its malignant mate.

have been completely destroyed. The picture is impressive and very definite.

Not all malignant lesions should be subjected to mammographic study. If they are situated in the subareolar or ampullic zone, it would seem unwise to manipulate them to the extent which is necessary in cannulizing the ducts. Likewise, malignant neoplasms are more prone to develop in the aged, when the breasts have undergone marked involution, and the ducts are no longer patent. It is in such instances that aeromammograms have proved most useful, for the contrasting gas merely surrounds the breast tissue and differentiates the neoplastic from the normal structures.

A carcinoma appears as a rather dense irregular mass, devoid of the normal lobular striations. Its periphery is indefinite and feathery, seeming to blend insensibly into the matrix tissue. There is definite evidence of invasion of regional structures for in advanced cases there are fibrous bands which appear to connect the neoplasm with the skin and pectoral muscles and obliterate the normal premammary and retromammary zones (Fig. 27). Occasionally the lymph nodes are seen as dense, discrete, opaque masses, but Pendergrass[22] is of the opinion that "small visible lymph nodes in the axilla are not incompatible with the healthy breast." Scirrhous lesions are usually small and the dense cicatrizing process produces a distorted shadow by puckering, scarring and infiltrating the neighboring structures (Fig. 28). The

FIG. 27. Cancer. The indefinite outline, the feathery periphery, and the dense homogeneous consistency of the tumor signify carcinoma.

periphery of a scirrhous tumor is indefinite and fuzzy and pseudopodic extension of neoplastic material can be seen infiltrating the regional matrix. Such a lesion must be differentiated from an inflammatory fibrosis which always lacks the appearance of invasion.

Not only are these mammograms valuable diagnostic aids, but they also furnish information as to the type of therapy to be used. If the lesion is still confined to one section of the breast and has not invaded regional structures, surgical interference is justified, but where the neoplastic cells have invaded the skin, muscles and chest wall, as in Figure 29, they have gone far beyond the reach of the scalpel. Deep roentgen therapy and interstitial irradiation offer these advanced cases more security than a combination of surgery and irradiation for the former merely stirs up malignant growth without removing it.

Mammographic studies have forcibly emphasized several important points which

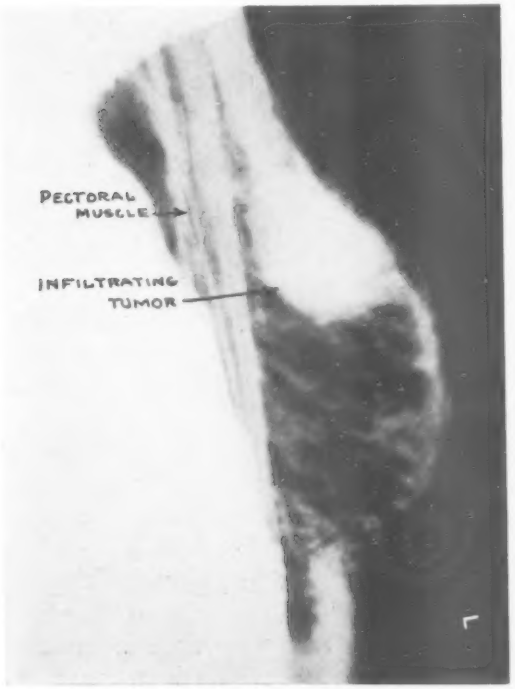

Fig. 28. Scirrhous carcinoma. The dense fibrotic nature of the tumor, combined with the invasion of the pectoral fascia and the absence of demarcation from normal matrix is significant of cancer.

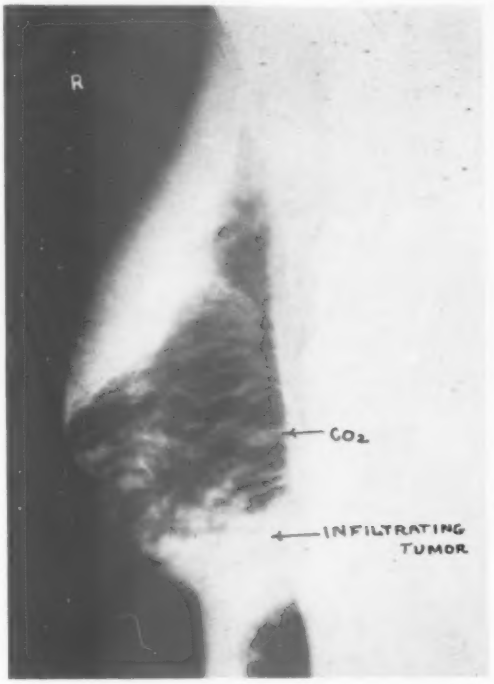

Fig. 29. Cancer. The tumor mass has become so firmly attached to the skin and the underlying muscles that it cannot be separated by the diffusing CO_2. This roentgenographic evidence of fixation contraindicates operation.

should be considered in the surgical treatment of mammary carcinoma. In the first place, the visualized milk ducts very closely approximate the skin, sometimes being contiguous with it. It is essential, therefore, that reflected skin flaps should be thin and not contain much adipose tissue, so that no glandular substance will be adherent. Second, the lactiferous tubules occasionally descend into the epigastric notch, pass across the midsternal line, and invariably ascend into the axilla. Hence, the entire glandular and muscular tissue of this area should be removed, and no remnant of mammary tissue should be overlooked. Third, the milk ducts may penetrate the pectoral muscles and their fascia and extend into the retropectoral space, making it essential to remove these muscles. Haphazard and incomplete surgery is of no value and unless all breast tissue is removed, no operation should be attempted.

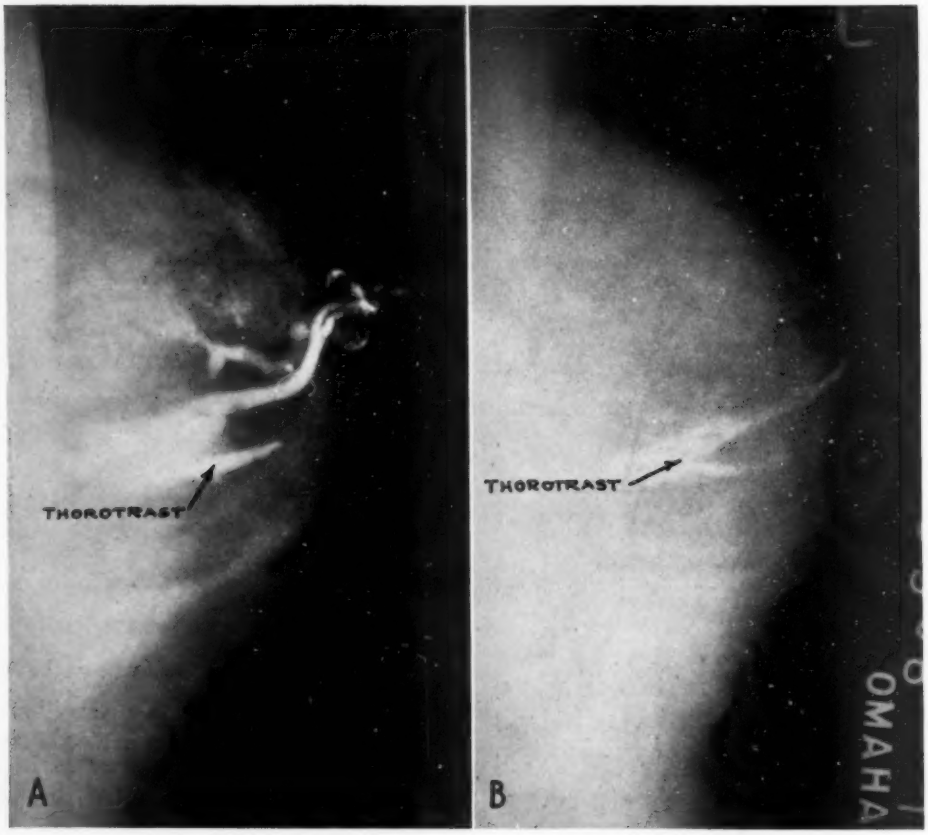

FIG. 30. *A*. Five cubic centimeters of thorotrast was injected into one duct of a gravid breast on the third post-partum day. As the breast was being "dried up" no attempt to evacuate the ducts by massage, aspiration or nursing was made. *B*. Five days later the same breast has retained but a small amount of the thorotrast as the major portion has escaped spontaneously from the nipple.

DISCUSSION

Three questions invariably present themselves whenever the subject of mammography is discussed. First, why are these visualizing mammograms necessary? Second, is it not better to be guided by histological studies of biopsied tissue than by contrast mammograms? Third, are there any complicating sequelae?

Mammograms are necessary because physical examination frequently fails to give sufficient information concerning the nature of the offending tumor. For instance, papillomas of the milk ducts are frequently so small that they cannot be palpated and yet they can be accurately located by means of thorotrast visualization. Cysts which communicate with the neighboring ducts are usually collapsed and hence are not palpable, but when the discharging ducts are distended with thorotrast, the cyst fills up so that it can be felt and can also be seen on the roentgenogram. Just how frequently this type of tumor occurs is questionable but we have demonstrated 3 such cases in the past four months, all of which had been overlooked in routine examinations.

No one has trouble in recognizing the large retention cyst or a well-developed carcinoma but everyone experiences difficulty in properly evaluating the small, deep-seated mammary tumors. The frequency with which exploratory biopsies are employed affirms this. Every case presented in this series had one or more con-

flicting diagnoses made, in spite of the fact that they were seen by surgeons with considerable experience. It seems that any procedure which gives definite information concerning the true nature of the elusive tumors is well worth while. Uncertain diagnosis has led to countless mastectomies for galactoceles, blue dome cysts, papillomas, lipomas, fibroadenomas, and painful breasts, many of which might have been avoided by utilizing mammograms. On the other hand, too many radical operations have been attempted for malignant lesions which have spread to regional structures, simply because the surgeon had no way of estimating the extent of the disease process. Such information is easily obtained by these new procedures.

Histological study of biopsied tissue affords an excellent and effective method of diagnosing mammary neoplasms, but it has an undesirable reaction on patients. The knowledge that every tumor, benign or malignant, must be operated on causes the patients to defer medical consultation as long as possible. Instead of seeking advice when the lesion is small and first observed, they frequently wait until undesirable sequelae have developed. It is true that aspirational biopsies have eliminated much of this fear, but such studies are not available to everyone. The pathologist must have special training before he is able to hazard a diagnosis based on the morphological contour of a few aspirated cells.

The habit of biopsying every breast tumor is productive of considerable damage by encouraging incompetent men to

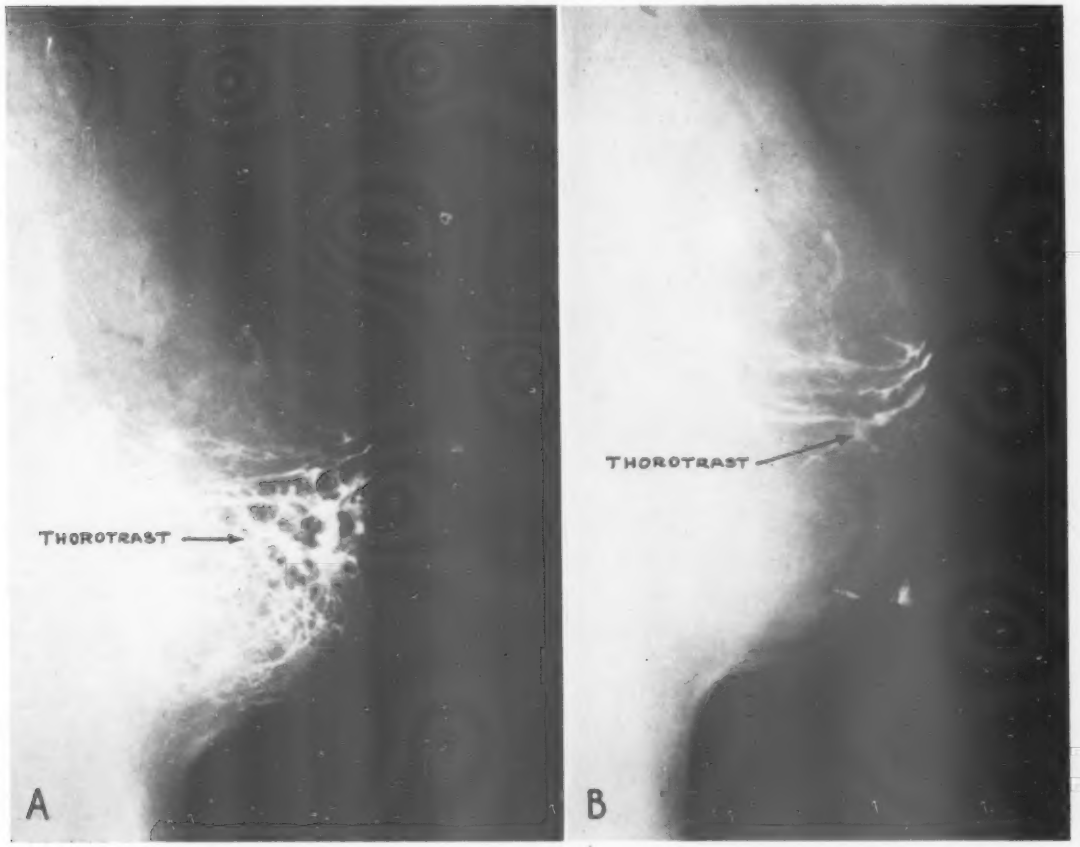

Fig. 31. *A*. The mammogram shows one lobule of a multiparous breast distended with 4 cc. of thorotrast. No attempt was made to evacuate the solution. *B*. Six days later the greater part of the thorotrast had escaped by draining through the ductal orifice.

attempt surgery. In smaller communities, it is sometimes the practice to excise the local "tumor" and send the specimen to a neighboring pathologist for diagnosis. If the belated report confirms the presence of malignant tissue, the patient has then to be referred to some distant surgeon for correct therapy. Usually the primary operation is performed without precaution as to the dissemination of neoplastic cells and such haphazard methods merely serve to scatter the malignant tissue. No one should attempt a biopsy or excision of a local breast tumor who is not capable of recognizing malignant tissue and who cannot proceed with a radical operation should it be necessary.

These studies encourage a patient to seek advice, for tumors can be correctly diagnosed without operation. Unnecessary mastectomies are avoided and multilating radical procedures are not employed in hopeless cases.

Complications are indeed rare. During the past twenty-six months a total of 625 mammograms have been taken on virginal, lactating, involuting and diseased mammary glands. Within the early period of this study, 3 breast abscesses developed following the use of thorotrast. All occurred within five days after the initial injection and were caused by introducing the solution into the periductal tissues. In 2 other instances, the ducts were submitted to too much pressure and the smaller lacteals ruptured, permitting the thorotrast to seep into the matrix structures, but only a mild non-suppurative inflammation resulted. Refinement of technique and increased experience have eliminated these difficulties.

Acute mastitis contraindicates all forms of visualizing studies as the manipulation activates the infective process. Lactating breasts can be studied without fear of complications or interference with nursing. We have carefully roentgenographed several infants who have suckled breasts which have been injected with thorotrast and no evidence of absorption by the baby could be found.

There is no doubt that the breast can be effectively visualized with contrast substances. Experience will greatly enhance the usefulness of such studies by developing new radiopaque solutions and perfecting the technique. Even our limited experience indicates that contrast mammograms are very valuable in the diagnosis and treatment of mammary neoplasms.

CONCLUSIONS

1. The anatomical arrangement of the milk ducts and secretory mechanism of the breast can be visualized roentgenographically by injecting radiopaque substances into the milk ducts or surrounding the matrix with CO_2.

2. Stabilized thorium dioxide sol and CO_2 have proved to be the most suitable visualizing agents.

3. Such neoplasms as lipoma, fibroma, papilloma, cysts, galactoceles and carcinoma have been visualized and diagnosed by these methods.

4. Contrast mammography likewise furnishes an excellent method of studying the physiological changes which occur in the normal breast.

5. In a series of 625 mammograms, only three cases of breast abscess have occurred, each developing after the accidental extravasation of thorotrast into the periductal tissues.

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PLASMA CELL MYELOMA*

REPORT OF TWO CASES WITH UNUSUAL SURVIVALS OF SIX AND TEN YEARS

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THE poor prognosis in cases of multiple myeloma and the fact that this disease usually terminates fatally in about two years has focused our attention upon 2 patients who have had this neoplasm for six and ten years respectively while under medical observation. Judging from previous experiences, the findings in both of these cases were originally such that we were led to believe their course would be rapidly downward and that death would follow in a relatively short time. Contrary to predictions, however, one of these individuals lived for a decade before succumbing, and the other is in good general health at the end of six years. These unusual durations for the existence of myelomata prompt us to record the observations and to point out the means whereby this more favorable type may be recognized.

Myelomata are bone marrow tumors which may be divided into four classes, depending upon the presumed origin of the neoplasm or the type of cell predominating, namely, erythroblastoma, lymphocytoma, myelocytoma and plasmocytoma. It is in the last category that the 2 cases herein reported must be catalogued.

FIG. 1. Case 1. Roentgenogram of the left forearm, March, 1931, with area of bone destruction in the ulna with pathological fracture at this site. (Fracture was seen better in a lateral view.) Small destructive lesion also seen in the radius.

REPORT OF CASES

CASE 1. W. J. K., a white male, aged sixty-six, entered the hospital March 28, 1931, complaining of pain in the right hand and left forearm. Six months previously a lump appeared on the back of the right hand which had since been persistently painful. At about the same time a similar lump appeared over the right external malleolus. Both of these masses had gradually increased in size. On March 24, while lifting a heavy object, he heard a snap in the left forearm and experienced severe local pain which continued until hospitalization.

Physical examination showed an elderly man, somewhat undernourished, but in fairly good physical condition. Over the dorsal aspect of the second metacarpal bone on the right was a swelling about 3 cm. in diameter and 1.5 cm. thick. The external malleolus of the right ankle was diffusely enlarged. There was a distinct fusiform enlargement over the upper end of the left tibia just below the knee joint. Each of these three swellings was tender. In the middle third of the left ulna there was extreme tenderness with deformity indicative of fracture.

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Roentgen Examination. A film of the left forearm showed an irregular area of bone destruction, about 3 cm. in length, at the junction of the middle and lower thirds of the ulna, with a pathological fracture through this zone (Fig. 1). There was also a clearly circumscribed hole about 3 mm. in diameter in the radius just opposite this. A film of the right hand showed similar areas of central destruction in the distal end of the second metacarpal bone, at the proximal end of the fifth metacarpal bone and also in the distal phalanx of the index finger. A film of the right ankle showed a large, similar cystic area in the lower end of the fibula (Fig. 2). Films of the knees showed (in addition to hypertrophic arthritis and calcified joint mice) large coarsely trabeculated and cystic appearing areas of destruction in the upper end of either tibia—most marked on the left (Fig. 3).

Fig. 2. Case 1. Roentgenogram of the right ankle, March, 1931, showing large trabeculated area with defect in lower end of the fibula.

There were multiple small defects (varying from 2–5 mm. in diameter) in the lower end of the left tibia, in the left astragalus, in both patellae and in the right fifth metatarsal bone. The skull had a single rounded defect 6 mm. in diameter in the left parietal bone and several similar changes in either side of the mandible. The right shoulder showed a multilocular cystic area in the outer end of the acromion quite similar in appearance to those noted in the other bones.

Fig. 3. Case 1. Roentgenogram of left knee, March, 1931, showing large cystic appearing lesion at upper end of tibia (multiple, calcified joint mice behind femoral condyles).

Course. The fractured ulna was treated with immobilization, and bony union was evident within two and one-half months. On April 10, 1931, a biopsy was taken from the neoplasm at the lower end of the right fibula.

Pathological Examination. The specimen consisted of a fragment of tissue 2×0.8×0.8 cm. which was moist, soft, reddish gray, and appeared to be very cellular. There were a few small scattered hemorrhages which were probably caused by operative trauma. Microscopically, the findings were typical of a plasma cell myeloma. The neoplasm consisted of broad sheets of closely packed plasma cells with only a very delicate supportive stroma (Fig. 4).

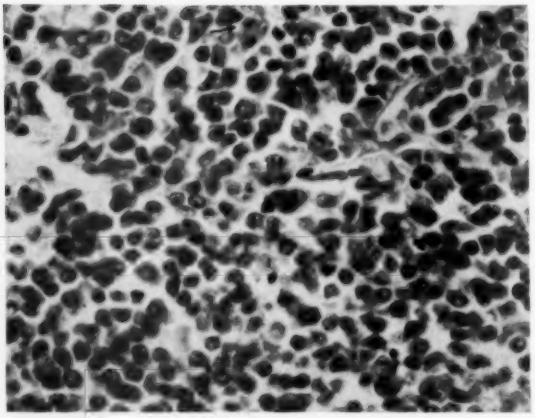

Fig. 4. Case 1. Photomicrograph (×225) of plasma cell myeloma (biopsy from lower end of fibula, see Fig. 2). Tumor of high cellularity, consisting mostly of plasma calls, with little stroma. Arrow indicates mitotic figure.

The individual cells were rounded, oblong, or polygonal, and varied somewhat in size from about 7 to 11μ in greatest dimensions. The features which characterized the cells as being of the plasma type were the "cartwheel" arrangement of the nuclear chromatin and the presence of a basophilic cytoplasm containing a small irregular eosinophilic zone to one side of the eccentrically placed nucleus (Fig. 5). Occasionally a cell contained two nuclei. Mitotic figures appeared in only moderate numbers, one or two being found in a high dry objective field (0.3 mm. in diameter). The tumor had a low vascularity and the vessels were mostly of capillary size. There were no necroses, but a small number of nuclei were shrunken and pyknotic. The bone marrow had been crowded out and no erythropoietic tissue was identified in the sections.

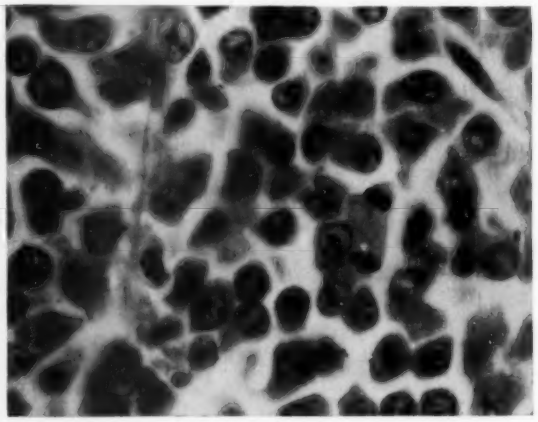

Fig. 5. Case 1. Photomicrograph (×650) of plasma cell myeloma, from same biopsy specimen as Figure 4. Mitotic figure just to right of center of photograph.

In September, 1932, roentgenograms of the right elbow showed a large area of destruction breaking through the cortex of the olecranon process, also multiple small clean-cut areas of destruction scattered in the shafts of the ulna and humerus. The left elbow contained large rarefied, irregular areas in the lower end of the humerus and also smaller scattered lesions in the upper end of the radius and ulna (Fig. 6).

Fig. 6. Case 1. Roentgenogram of left elbow, September, 1932, showing defects in humerus, radius and ulna.

Laboratory data on various studies during the interval from 1931 to 1936 showed a white blood count varying from 6,100 to 8,400, with essentially normal blood smears. During this time, numerous urine examinations were negative for Bence-Jones protein. In March, 1934, blood chemistry showed a total protein of 7.0 mg. per cent, serum albumin 4.5 mg. per cent, serum globulin 2.5 mg. per cent, blood calcium 11.8 mg. per cent, blood phosphorus 2.9 mg. per cent and blood cholesterol 180 mg. per cent. In June, 1936, the blood chemistry showed a total protein of 6.4 mg. per cent, serum albumin 4.3 mg. per cent and serum globulin 2.1 mg. per cent.

During the five-year interval until 1936 the patient was given repeated roentgen therapy over the involved areas whenever there was a

complaint of pain. Intensive irradiation has not been given, the average treatment consisting of about 300 r, with one repetition of this dose in two or three days. This has always given prompt relief of pain and has usually been followed by slight evidence of partial healing in subsequent roentgen examination. During the entire period from the first appearance of the swellings in 1930 until the present time—August, 1936—the patient's general health has been quite satisfactory and he is still vigorous and active.

FIG. 7. Case II. Photographs of patient, November, 1934, showing swelling in region of right maxillary antrum and cheek.

CASE II. R. Z., a sixty-five-year-old Jewess, was admitted to the hospital November 21, 1934, complaining of a swelling on the right side of her face for one and one-half years and profuse epistaxes for six weeks. For three years there had been a swelling over the midportion of the right tibia. She had lost 10 pounds in weight during the past year.

The patient had been treated in another hospital in December, 1926, at which time Dr. V. H. Kazanjian removed about half of the left maxilla in order to enucleate a tumor mass that measured about 4 cm. in diameter.

Pathological examination of the specimen removed at that time showed a plasmocytoma. Dr. Kazanjian saw the patient in August, 1928, and found no evidence of recurrence of the tumor. He then saw her next in November, 1933, at which time there was an extensive mass on the right side of the face, involving the palate and extending into the antrum. She was advised to have roentgen treatments but refused.

Physical examination (when seen by us) showed an apprehensive, short-statured, fairly well-nourished, elderly and slightly pale woman. There was a large, smoothly rounded, tense, globular swelling occupying the right zygoma and maxillary antrum which bulged out the overlying skin (Fig. 7) and which protruded into the roof of the mouth on the right. There was a midline scar on the upper lip and a defect in the hard palate on the left as results of the former operation. The mouth was edentulous. Over the midportion of the right tibia was a fusiform thickening of the bone.

Roentgen examination showed a fairly large lobulated mass in the region of the right antrum destroying the maxilla and projecting into the nasal cavity. The right malar bone was par-

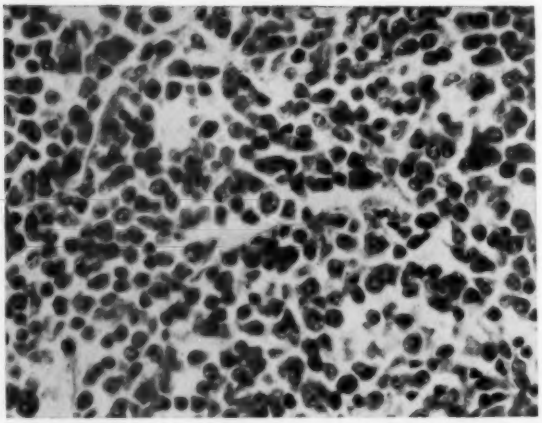

FIG. 8. Case 11. Photomicrograph (×225) of plasma cell myeloma, removed from the maxillary antrum. The neoplasm is composed almost entirely of plasma cells and has practically no stroma. Several capillary size blood vessels are seen.

tially destroyed. The left side of the hard palate and part of the left maxilla were missing (postoperative), but the tumor did not extend over to this area.

Laboratory Data. Urine—four specimens showed a trace of albumin. Examination for Bence-Jones protein was unfortunately not done. White blood count 11,000, red blood count, 4,600,000, normal blood smear.

Course. On November 23, 1934, Dr. Elliott C. Cutler performed a radical excision of the neoplasm of the right antrum and malar region, approaching the tumor through the roof of the mouth. Five days after operation two roentgen treatments, 350 r each, were given over the right cheek and these were repeated six weeks later.

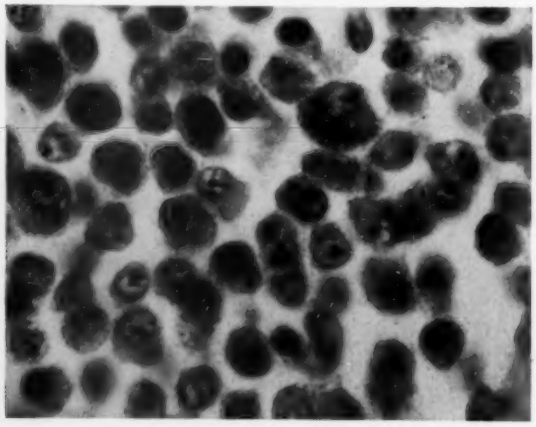

FIG. 9. Case 11. Photomicrograph (×650) from same specimen as shown in Figure 8.

Pathological examination of the specimen showed a mass of non-encapsulated neoplastic tissue measuring 6.5×6×4 cm. in overall dimension and weighing 72 grams. This was soft, resilient, somewhat friable and of uniform structure. The external surface, as well as cut sections, was moist, yellowish gray, and had the appearance of a highly cellular tumor. There were scattered punctate areas of necrosis.

FIG. 10. Case 11. Photograph of patient, July, 1935, showing soft tissue tumor growth below right groin and also in central portion of right lower leg.

Microscopic study showed a highly cellular neoplasm of plasma cell myeloma type (Figs. 8 and 9). The cells varied in size from 8 to 16μ in greatest diameter, were rounded or oblong, but often had a polyhedral shape. The rounded nuclei had moderate amounts of chromatin, largely distributed in a "cartwheel" arrangement characteristic of plasma cells. The cytoplasms took a basophilic stain but in most of the cells there was a small eccentrically placed eosinophilic zone just outside of the nuclear membrane. Mitotic figures were numerous, four or five being seen in some high dry fields (0.3 mm. in diameter). The stroma was quite

scanty in amount. The vascularity was relatively low. Scattered small areas of necrosis were seen. (The histological picture was essentially the same as that found in the reviewed sections of the left antral tumor removed eight years previously.)

In July, 1935, the patient returned complaining of pain over the midshaft of the right tibia and painful swelling in the right groin. Examination showed her to be considerably emaciated and quite pale. There was an irregular, firm, nodular and flattened mass about 8 cm. in diameter apparently comprised of greatly enlarged femoral lymph nodes (Fig. 10). Over the midportion of the right tibia was a soft and tender swelling about 6 cm. in length which was attached to the underlying bone.

Laboratory Data. The urine contained a trace of albumin in two specimens. Tests for Bence-Jones protein were negative. Blood cholesterol 279 mg. per cent, blood calcium 10.8 mg. per cent and phosphorus 4 mg. per cent; white blood count 9,900, red blood count 3,050,000.

Roentgen examination of the chest showed the lungs to be clear. A film of the pelvis was negative for bony involvement. A film of the right tibia showed a multilocular cystic area in its middle third measuring 7×3.5 cm. (Fig. 11). This was circumscribed except in its posterior aspect where the cortex was broken through. A film of the right foot showed almost complete destruction of the os calcis and marked demineralization of the remaining bones of the foot (Fig. 12).

Fig. 11. Case 11. Roentgenogram of right lower leg, July, 1935, showing large, trabeculated, cystic appearing lesion in the midshaft of the tibia.

Two roentgen treatments, 350 r each, were given over the tumor mass in the right tibia, and two similar treatments over the right os

Fig. 12. Case 11. Roentgenogram of right foot, July, 1935, showing extensive destruction of os calcis by neoplasm.

calcis. Four treatments, two anteriorly and two posteriorly, 300 r each, were given over the tumor mass in the right femoral region. These afforded prompt relief of the pain.

The patient returned two months later with a recurrence of pain (without visible swelling) in the right cheek and three roentgen treatments, 300 r each, were given over this area. There was now a marked decrease in the size of the mass below the right groin. The patient was then lost and was known to have died outside of the hospital in May, 1936, nine and one-half years after the original diagnosis of plasmocytoma was made and ten years after she had had the first symptoms from this neoplasm.

COMMENTS

Studies of the literature show that there has been increasing evidence that an occasional myeloma may take the form of a solitary lesion for many years and then later become generalized and more malignant. Cutler, Buschke and Cantril[3] have studied 20 such cases. Included in their series were 2 patients observed for four and ten years respectively who were alive and without evidence of generalized metastases at the time of their report.

We have studied our 2 patients in an attempt to find the characteristics which will enable us in the future to pick out the cases of multiple myeloma which have a relatively good prognosis. In the following discussion the various findings—pathological, roentgenological, hematological, etc.—are evaluated with reference to their significance in separating these more favorable cases from the more numerous, malignant ones.

Roentgen Appearances. In the lesions of the 2 cases herein reported, the roentgen changes varied considerably. In Case 1, many of the bony defects were small, punched out, and rounded in appearance, but in the second case these small lesions which are commonly found in multiple myelomata were missing. In these 2 cases, most of the bony changes were quite large, were sharply circumscribed, and measured as much as 10–12 cm. in overall dimensions. These larger lesions had a multilocular, cystic appearance and often exhibited some expansion of the diaphyseal cortex. These lesions occurring at the end of a long bone (such as Fig. 2 or Fig. 3) would strongly suggest giant cell tumors but the presence of *multiple ones in one patient or the presence of a cystic-appearing lesion in the middle of a shaft* (as Fig. 11) is distinctly against the diagnosis of giant cell tumor. (We noted that these large lesions, such as the one at the upper end of the left tibia in Case 1 and in the midshaft of the right tibia in Case 11, were definitely *hot* to touch, but they did not crepitate to firm pressure as a giant cell tumor does.) The distribution of the bony changes by roentgen examination is an aid in identifying the relatively benign type of myeloma. Geschickter and Copeland,[5] in discussing the usual malignant myeloma, list the extremities—below the knees, and below the middle third of the humeri—as being the rare sites of skeletal involvement. In contrast to this we have found in our 2 cases of the benign form that the lower end of the humerus, the radius, ulna, small bones of the hand as well as the tibia, fibula and tarsal bones were extensively involved.

Pathological Findings. Microscopic examination of biopsy material from these 2 cases has been disappointing for the reason that histological study does not afford any method of differentiating these slowly growing forms from the more malignant ones. The cellularity, the number of mitotic figures, the amount of stroma and the vascularity are all essentially the same as one is accustomed to find in malignant and rapidly growing fatal plasma cell myelomata. One would expect that microscopic examination of material from our 2 cases would show some evidence of slower growth, but we were unable to detect such variations. Possibly more complete examination of material from autopsy specimens might give a clue in differentiating the slowly and rapidly growing forms of plasmocytoma, but in our biopsy material (which has been generous) we could not find important differences. One can state

with some certainty, however, that *given a neoplasm which simulates a giant cell tumor in the roentgenogram* (such as Fig. 2) *and finding the histological picture of myeloma on biopsy of this lesion, it would appear that the benign form of the myeloma is being dealt with.* An additional illustration of these findings of "giant cell tumor" by roentgen ray and myeloma by biopsy is presented in the case of Holmes and Ruggles[6] which had changes in the second lumbar vertebra diagnosed benign giant cell tumor and treated with irradiation in 1925. This patient was operated upon December 15, 1930, and the specimen removed at this time was diagnosed myeloma. There was no other bone lesion. A subsequent report on this patient[7] adds that there had been lumbar pain since 1920 and that the patient is alive in 1936 but has had extensive involvement of the vertebrae, eleventh thoracic to the third lumbar, since 1934. The total duration of this neoplasm, to date, is probably about sixteen years.

Urinary Findings. They give no clue concerning differentiation of rapidly and slowly growing myelomata. Neither of our cases showed Bence-Jones protein in the urine, but since this type of protein is found in only 70 per cent of all myelomata, the absence of this finding in a given case has little significance.

Blood Findings. In our first case the blood calcium was slightly elevated above normal values and the blood phosphorus was decreased, but variations to such levels may be found in any case where there is destruction of bone from any cause. In our second case, with less osseous involvement, the blood calcium and phosphorus were within normal limits. Examinations of blood smears in both patients showed no evidence of circulating plasma cells as is occasionally described in patients with myelomata.

Age Groups. The ages (sixty-five and sixty-six years) of the cases herein reported do not differentiate the slowly growing myeloma for it is in the latter half of life (with a peak of incidence at fifty-five years) that myelomata are most common.

Response to Roentgen Treatment. The malignant and benign forms of myeloma react differently to roentgen irradiation. In the patients here presented there was prompt clinical response to this treatment, with cessation of pain, decrease in swelling, and healing of the bony defects. This is in contrast to the usual (malignant) multiple myeloma in which pain may be relieved but the lesions progress and the patient dies.

SUMMARY

Two cases of plasma cell myeloma are reported, in each of which there was an unusual duration of life after development of the neoplasm. In the first case, the patient is in excellent general health, but has roentgen evidence of persistent skeletal lesions, six years after the disease was recognized. In the second case the patient lived for a period of ten years after development of the first signs of the neoplasm. Roentgen therapy (600–800 r)* to the individual lesions gave immediate relief of pain and the bony defects were partially repaired by calcium deposition and new bone formation. Pathological examination of biopsy material from both of these patients showed findings typical of plasma cell myeloma and no histological differences could be found to separate these slowly growing forms from the more common malignant ones. Roentgen examination, however, demonstrated distinct variations from the rapidly fatal types of myeloma, for in these two cases there was, first, involvement of the extremities distal to the elbows and the knees and, second, formation of multiple, large, multicystic appearing lesions in the center or the ends of long bones. The finding of a histological picture of plasmocytoma from a bone lesion which roentgenologically resembles a giant cell tumor apparently justifies the diagnosis of a myeloma of relatively benign type.

* Treatments usually divided into two irradiations, two days apart, each averaging 300–400 r, employing the following factors: 140–180 kv., 4 ma., target-skin distance 40 cm., 0.5 mm. copper and 1 mm. aluminium filter, exposures 25–30 minutes.

It appears that a myeloma is not always a rapidly fatal neoplasm, but that it may exist for many years in a localized form or indeed may have multiple bony lesions and yet possess a slow rate of growth and a good prognosis.

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ROENTGEN STUDIES OF THE PATHOLOGICAL PHYSIOLOGY OF BRONCHIAL ASTHMA*

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THE conception of the pathogenesis of bronchial asthma has centered largely around the question of spasm of the bronchial musculature. The asthmatic attack has loomed so large in the mind of the clinician that a transient change in the caliber of the bronchi has seemed to be the crux of the situation. Recent investigations, particularly of the pathology of the lungs in allergic asthma, have served to throw doubt on this idea, and roentgenologic studies by means of the introduction of iodized oil into the bronchi, i.e., bronchography, reveal a feature of the pathogenesis of bronchial asthma which has been insufficiently emphasized.

The study of the pathology of bronchial asthma is made difficult by several factors. First of all, because of similarity in symptoms, numerous cases of various types are classified under the term "asthma" by the clinician; in many of these the asthma is a symptomatic manifestation of a respiratory disorder rather than a primary bronchial disease. An uncritical acceptance of such material by the pathologist may lead to an erroneous conclusion; on the other hand, exclusion of all cases that do not conform to a chosen pattern may be equally misleading.

The second difficulty is the superimposition upon the picture of asthma of extraneous abnormal changes associated with the final illness or with past intercurrent bronchial or pulmonary infections. Examples of such confusing lesions are bronchitis, pneumonia, atelectasis, fibrosis, anthracosis, peribronchial lymphangitis, and similar conditions, all of which are frequently found coexistent with asthma. Very frequently these nonspecific lesions so modify or obscure the true pathology of asthma that the post-mortem study is of no value whatever.

Finally, there is the theoretical possibility that the asthmatic lung at the time of death represents a broken down, decompensated organ, not at all representative of the true condition present during the early stages of the disease.

The problem, therefore, is to establish an "average" or characteristic picture of the pathology of bronchial asthma, and to correlate the post-mortem findings with conditions during life. In the absence of biopsies of the bronchi, the roentgen studies of the lungs and bronchi, particularly by means of bronchography, are extremely valuable. They permit us to study the course of the tracheobronchial tree, the size, shape and position of even the smaller bronchi, the degree of emphysema or atelectasis, the presence or absence of superimposed infection. When correlated with autopsy findings it is possible to learn something as to the pathological physiology of the disease.

There have been observed, occasionally, at autopsy, pure, uncomplicated cases of bronchial asthma without the confusing factors noted above. In spite of the frequency of the disease, however, there are only a small number of careful autopsy studies of such cases reported in the literature. Notable among these in the past few years have been the reports of Huber and Koessler,[11] Steinberg and Figley,[18] Kountz and Alexander,[12] Wright,[19] Fisher and Beck,[9] Macdonald,[13] and Bubert and Warner.[5] Almost uniformly these authors point out the presence of mechanical occlusion of the smaller bronchi by mucous plugs. While there is a marked difference of opinion as to whether there is a true thickening of the

* Read at the Fifth International Congress of Radiology, Chicago, Ill., Sept. 13–17, 1937.

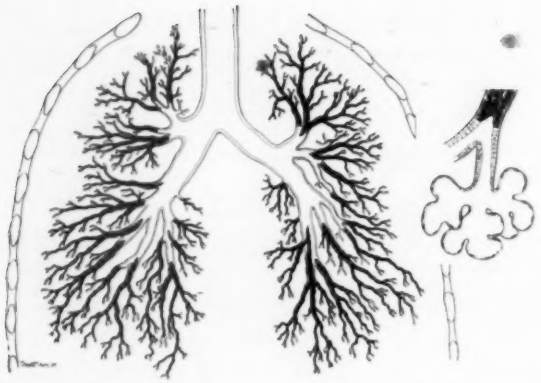

Fig. 1. Diagrammatic representation of the occurrence of mucous plugs in bronchial asthma. This diagram is based on a number of cases in which celloidin casts and microscopic sections were made by one of us (R.L.K.) to illustrate the position of the mucous plugs which partially occlude the smaller bronchi. It should be noted that the beginning of these plugs (black) is in the bronchi of the third bifurcation and that they do not extend completely up to the atria. Note also should be made of the clear spaces (white) which permit air to pass by the occluding mass.

bronchial wall and a real hyperplasia of the bronchial mucosa, there is no doubt that the most constant finding is the excess of mucous secretion appearing as masses occluding the bronchial lumen.

Roentgenologic studies, likewise, have been reported in recent years which tend to indicate the importance of this phenomenon. Notable among these is the paper of Steinberg[17] who found definite evidence of occlusion of the smaller bronchi in almost all the cases of bronchial asthma which he studied. Anderson[1,2] likewise has reported this finding observed by using iodized oil for therapeutic purposes. Sparks and Wood[16] and Christopherson[6] have also studied these cases by the use of bronchography. They did not emphasize the occlusion of the bronchi, although they observed it in their cases. A similar observation has been made by Singer.[10] The data presented here are based upon the reports in the literature together with our own observations of cases of asthma examined roentgenologically during life and of uncomplicated cases studied post mortem.

The gross pathologic examination of the typical uncomplicated case of asthma presents first of all a large, light, feathery lung. The pleura is smooth and not adherent. The hilum is soft and free from enlarged lymph nodes or fibrosis. The cut surface of the lung is dry and pink; scrutiny of the parenchyma with a lens shows dilatation of the alveoli and terminal bronchioli, but they contain no fluid or exudate. The large bronchi show little or no change; the medium and small sized bronchi stand out prominently from the cut surface because of the softness of the adjacent lung parenchyma.

Finally, the great majority of the smaller bronchi are completely filled with a solid, dry, yellowish mucus which can be grasped with forceps and pulled out of the lumen. It maintains its form and frequently exhibits branching; in all respects it is a cast of the bronchial lumen. A diagram representing the gross appearance of such a mucous cast in the bronchi, in a case of bronchial asthma producing partial obstruction of the bronchial tree, is shown in Figure 1.

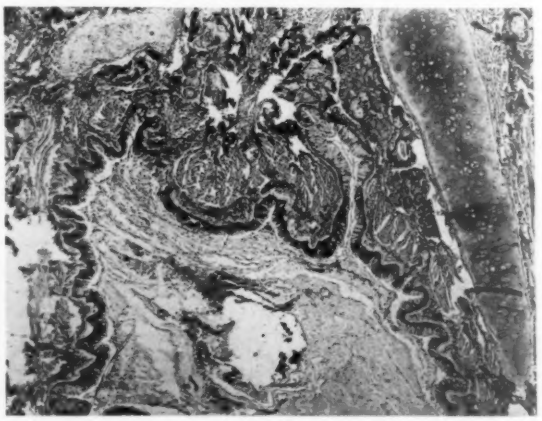

Fig. 2. Lower power microscopic section of a portion of a bronchus in a case of bronchial asthma. The bronchial wall is well shown including cartilage, muscularis and mucous membrane. Particular note should be made of the thickened muscularis, thickened basement membrane, and the marked accumulation of mucus in the glands. The mucus can be seen streaming out from the glands into the lumen of the bronchus. Within the bronchus itself a large mucous plug is shown with a cleft in its center and a small amount of air space around its periphery.

This mucous cast begins at about the third bifurcation extending distally as far as the atria. This, we believe, is the most prominent autopsy finding in true bronchial asthma, and this figure is characteristic of most of the cases examined. It appears that this bronchial plugging is highly characteristic of the asthmatic state, and in our experience an exactly similar process is not found in other pulmonary diseases.

Histologically the most characteristic change is an enormous hypersecretion of mucus by the epithelium lining the bronchi and by the submucous glands. The great excess of secretion flows into the lumen and twists itself into casts which, however, do not completely obstruct the bronchus. Canals and passages around the plug are maintained so that air can be drawn past the obstruction during inspiration. With the partial occlusion the less efficient efforts of expiration together with the decrease in the caliber of the bronchus which occurs normally during expiration prevent complete expulsion of air. The result is emphysema.

Eosinophilia of the mucosa and submucosa is constantly present in some degree. There is, also, a thick hyaline-like eosinophilic basement membrane, the significance of which is as yet unknown. The hypertrophy of the muscle bundles which has been described as a characteristic feature of bronchial asthma can usually be seen to some extent.

Fig. 3. Low power microscopic section of a portion of a bronchus showing particularly well the mucous plug within the bronchial lumen. The whorling and conglomeration of the mucus is well demonstrated. Note the very large cleft along the periphery of the plug permitting air to pass into the bronchus. The emphysematous alveoli of the lung around the bronchus are well shown.

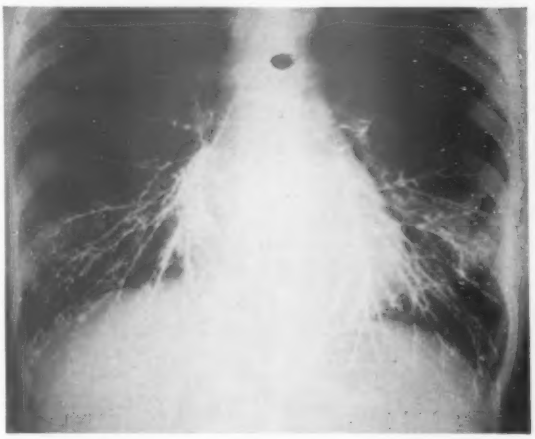

Fig. 4. Posteroanterior roentgenogram of the chest after bronchography in a case of bronchial asthma of mild degree in its early stages. Note the well-filled smaller bronchi extending well out to the periphery in both lower lobes. The caliber of the bronchi is distinctly narrowed as occurs in many early cases of bronchial asthma. There are no clear evidences of occlusion.

In addition, there are usually present in varying degrees, when infection has supervened upon the asthma, one or all of the following: congestion of vessels, edema, sloughing of the epithelium, polymorphonuclear or round cell infiltration, peribronchial fibrosis or lymphangitis and degeneration of the cartilages. Patchy atelectasis of the parenchyma may also be present. It is possible that this represents accidents in the course of asthma due to complete occlusion of certain bronchioles. It is notable that with such extensive casts within the bronchi complete closure does not occur more often.

The low power microscopic appearance of a cross section of a bronchus from a case of bronchial asthma is shown in Figure 2. Here the mucous membrane is shown in detail and a marked hypersecretion of mucus can be seen in the lining epithelium and the glands; the mucus itself is shown

streaming into the bronchial lumen. There can also be seen in this section the thickened basement membrane, the hypertrophied muscle bundles, and some minor cellular infiltration. Figure 3 is a low power microscopic section of a bronchus showing the detail of a mucous cast. Here the whorling and fusion of the streams of mucus into a conglomerate central mass partially occluding the bronchus can be observed. At the margin of this plug the cleft, which permits air to pass into the lungs through this partially obstructed bronchus, is apparent.

The question of thickening of the muscle fibers is of particular interest because it suggests overwork. There is no doubt that some increased thickness of the muscles of the bronchi is present. Partly, at least, this may be due to collagenous infiltration as can be shown by differential staining of the muscle masses. While the cause of the muscular hypertrophy has usually been assigned to bronchial spasm, it is important to note that this hypertrophy is often present in other types of chronic bronchial diseases in which there is retention of purulent exudate. It is possible that the muscle hypertrophy may be due to long standing and sustained efforts at expulsion of the mucous plugs and of air during expiration rather than to the transitory bouts of spasm such as probably occur during the asthmatic seizure.

A few cases have been reported in which numerous papillary projections of the mucous membrane into the lumen of the bronchus have been found. It has been thought that a true hyperplasia of the mucous membrane of the bronchi had occurred and that this hyperplastic epithelium had in itself acted as an obstructing mechanism. It is possible, however, that this papillary infolding of the bronchial mucosa is a transient phenomenon due to temporary muscle spasm upon an empty lumen. Sections of bronchi made distal to a mucous cast sometimes show this papillary infolding, suggesting that the cast had just been expelled from this more distal portion of the bronchus while it was still in a state of contraction, thus producing the infolding of the mucous membrane.

While great emphasis must be placed upon the presence of mechanically obstructing plugs in the bronchi, it must not be concluded that muscular spasm does not take place. There is no doubt that spasm is an extremely important factor. Its presence is indicated by the character of the asthmatic attack and the abrupt cessation following administration of adrenalin. As Steinberg and Figley[18] have pointed out, however, it is possible that the bronchial spasm may merely contribute to the degree of obstruction rather than be the primary cause of the obstruction itself. After the mucous plug is formed, the spasm merely increases the bronchial occlusion as the wall becomes more tightly closed down around the plug. As the attack subsides, relaxation of the muscle permits air to enter the bronchi again more freely through the partial opening which is present.

The autopsy studies on which the above findings are based will be reported in greater detail later by one of us.

The roentgen examination in the living individual tends to supplement and substantiate these pathologic findings. It is of particular value when repeated examinations are made on the same patient over a period of time, so that the development of the changes described above may be demonstrated.

The roentgenographic and roentgenoscopic examination of the chest in cases of bronchial asthma without the use of contrast substance has been repeatedly described. The results of this type of examination will not be considered here in any detail, except to point out that in the relatively uncomplicated cases the findings are essentially those of emphysema. It is important to note that many of the other findings, which have been described as occuring in bronchial asthma, are undoubtedly due to the complicating, superimposed infections described above. The presence of pleural adhesions, parenchymal

infiltration, great enlargement of the root shadows of the lungs and evidences of right heart hypertrophy all are secondary to the complications of bronchial asthma. The occasional areas of atelectasis may also be demonstrated in the ordinary roentgenogram in the relatively uncomplicated cases.

The introduction of iodized oil into the bronchi, i.e., bronchography, is of great value in the study of the abnormalities produced by asthma; it is notable that so little emphasis has been placed upon this procedure in the past. As stated above, there are a number of very informative studies recorded in the literature and these have led to some newer concepts of the asthmatic process. While the technique of examination is of great importance, space does not permit any detailed delineation of the method. The procedure has been described previously by Ochsner[14] and Ochsner and Nesbit,[15] Anderson[2] and many others.[3] In general, we have used the so-called passive method and lipiodol has been used as the contrast medium throughout these studies. While, in many of the cases, filling of the lower lobe bronchi on both sides has been done at one sitting, it is much better practice to fill each lower lobe separately, both from the standpoint of safety and also for improvement in the ability to interpret the findings. Stereoscopic, posteroanterior views and lateral views have been made and roentgenoscopic examination is done during the course of the procedure. One point should be particularly noted. This has been emphasized previously by Anderson[2] and we believe it has great merit. This concerns itself with the time interval between the introduction of the iodized oil into the trachea and the roentgenographic examination. Failure to take this sufficiently into consideration would make interpretation of the films

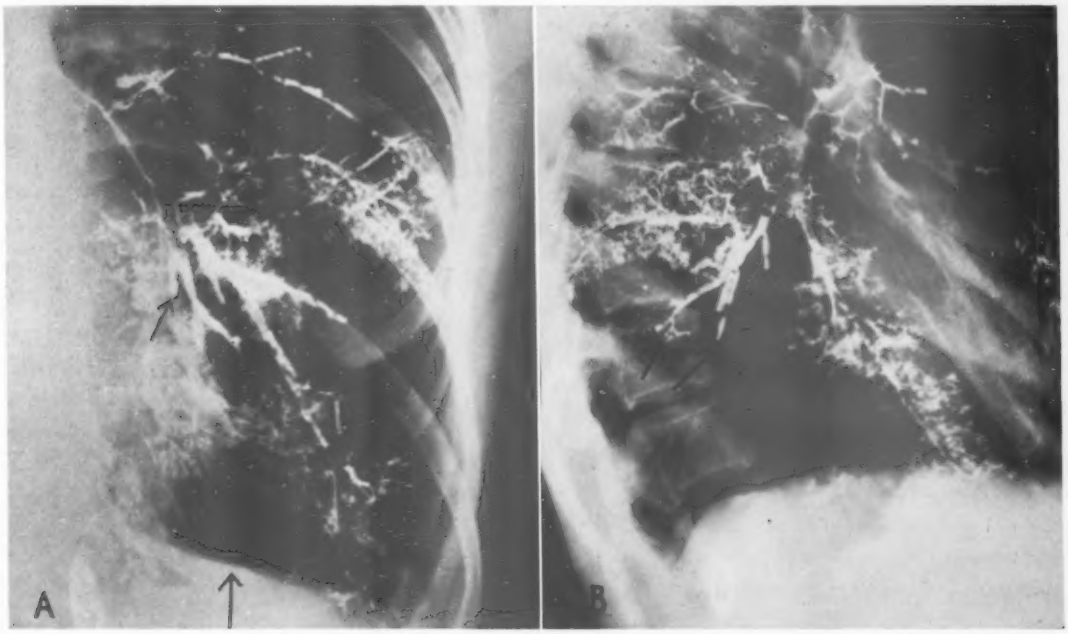

Fig. 5. Bronchogram of left lower bronchus in a case of bronchial asthma. *A*. Posteroanterior view showing partial obstruction of several of the bronchi. Note the rounded off distal ends (arrows), the large areas of the lung in which there is no iodized oil (arrow) in contrast with the good arborization obtained in the more normal portions. Note the emphysema of the lungs. *B*. Lateral view of the same case. The obstructed bronchi are well shown (arrows) and the rounded ends with absence of arborization in the area of the bronchial obstruction is well demonstrated. The extension of the iodized oil into other portions of the lung indicates that the technique of the examination was satisfactory.

Fig. 6. Posteroanterior roentgenogram after bronchography in an advanced case of bronchial asthma with marked emphysema. Note the numerous obstructed bronchi, especially on the left side with their abrupt rounded endings indicating mucous plug occlusions. A somewhat similar process is shown on the right side.

very difficult. From five to fifteen minutes must elapse between the time of introduction of the contrast medium into the trachea until it passes into the peripheral bronchi. If at the end of fifteen minutes filling of the peripheral bronchi has not taken place and the patient at the time of examination is not in the midst of an asthmatic attack, it is reasonable to assume that the failure to fill is due to distinct abnormality. On the other hand, in normal individuals, particularly if the oil is somewhat viscous and has not been sufficiently warmed before using, the contrast substance may be observed to be still present in the bronchi of the second or third order without filling of the more peripheral branches. Further observation five minutes later will reveal the filling of these peripheral branches. While it is important to avoid filling of the alveoli for various reasons, we have had relatively little difficulty in this regard. This is, we believe, particularly true in the cases of asthma, in which so much obstruction of the bronchi is frequently present that filling of the alveoli cannot occur in any event.

With careful observation of technique in the average normal individual, both the larger and smaller bronchi may be filled well out to the periphery. In early cases of bronchial asthma the only manifestation in the roentgenogram, after bronchography, may be a diffuse narrowing of the lumen of the bronchi. The bronchi will be filled well out to the periphery, but their caliber appears to be distinctly smaller than normal. This is well illustrated in Figure 4 in which the excellent distribution of the iodized oil through the lower lobes on both sides may be readily seen. The caliber of the individual bronchi, especially the smaller group, is distinctly less than the normal. This case illustrates, however, how complete a distribution may be obtained through the smaller bronchi in normal individuals if proper technique of administration is utilized and a sufficient interval of time permitted between the administration of the iodized oil and the making of the roentgenogram.

There is considerable doubt as to the cause of this diffuse narrowing of the bronchi whch is not infrequently observed in early asthma. Whether it is due to the pressure on the bronchi from the emphysematous lung or to a diffuse spasm is not yet determined. It has been reported by Sparks and Wood[16] that these narrow-lumened bronchi were demonstrated even after death, which throws some doubt upon the spastic origin of this phenomenon. Furthermore, it is observed in asthmatics during the intervals between attacks.

The most common finding, and one which is present in almost all cases examined, is obstruction of the smaller bronchi, particularly those beyond the third bifurcation. In these there is shown an abrupt termination of the column of iodized oil, the end of which is often rounded off or sharply defined. Careful examination of the roentgenograms will reveal no evidence

of air in the bronchial tube beyond the point of obstruction. The degree of this obstruction may vary considerably from one case to another and appears to be more marked in the more severe, later stages of bronchial asthma. The occlusions are present between attacks, and examination during the period of an attack may not produce any particular change in the degree of occlusion. An example of this finding is well shown in Figure 5. Here there is some dilatation of the smaller bronchi and a number of them, shown in both the posteroanterior and lateral views, are completely obstructed. These films were made after a period of at least ten minutes had elapsed from the introduction of the oil, and the absence of any of the contrast medium in large segments of the lung indicates clearly the occlusion of the bronchi which supply these areas. As Steinberg[17] has well pointed out, the absence of arborization, i.e., the failure of the oil to extend into the alveoli in large segments, is characteristic of bronchial obstruction. It occurs almost constantly with bronchiectasis and may also be shown in bronchial asthma when occlusions of the bronchi have occurred.

The examination of a large number of cases of allergic bronchial asthma has revealed findings similar to those in Figure 5 in a very high percentage of the cases. The degree of this obstruction may be much more extreme. In Figure 6 is shown a case of long standing in which it is obvious that the major number of the bronchi of the lower lobes are partially occluded. Extreme emphysema is present here and this may be a factor in the compression of the bronchi. Nevertheless, the observation of the rounded off obstructed ends of a large number of bronchi on both sides is characteristic of the presence of an actual plug within the bronchial lumen. We have examined a number of these patients with bronchography in which findings such as observed in Figure 6 have occurred. Some time later, autopsy studies have revealed characteristic mucous plug occlusions of these same bronchi exactly similar to those described above (Figs. 1, 2 and 3).

In the examination of these films it is notable that in some areas of the lung the oil can be seen distributed well out to the periphery. This is good evidence that the failure of distribution of oil to other areas

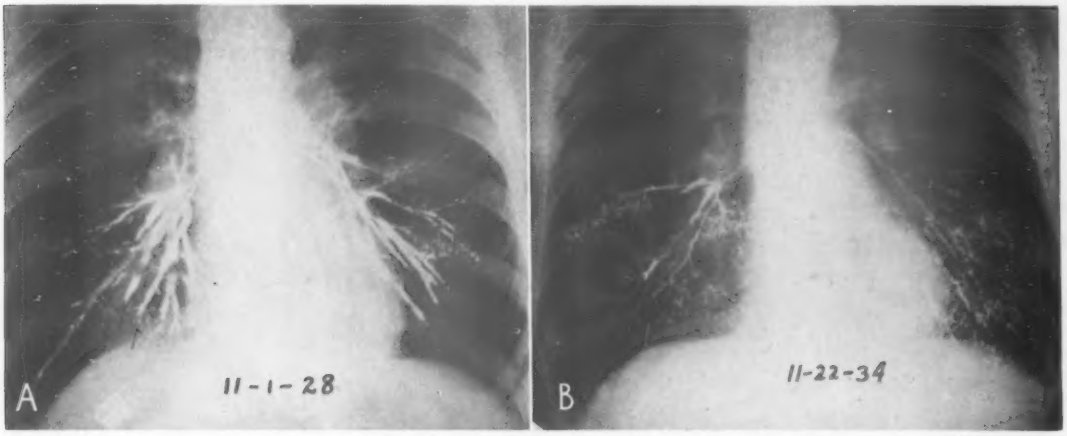

Fig. 7. Posteroanterior roentgenogram after bronchography in a case of bronchial asthma with bronchiectatic symptoms. *A*. First examination November 1, 1928, showing numerous obstructed bronchi. The rounded-off abrupt endings of these bronchi are well shown (arrows). There is only a moderate emphysema. The bronchi themselves show some cylindrical dilatation. *B*. Six years later after therapy and marked improvement in symptoms. Note the excellent distribution of the iodized oil into the left lower lobe with little or no evidence of obstruction. On the right side, however, there are several obstructed bronchi with absence of oil in these areas (arrows). The dilatation of the bronchi has largely disappeared.

of the lung was not due to accident or technical failure, but rather to actual mechanical obstruction of the flow.

In more advanced cases marked irregularity of the bronchial lumen with a considerable degree of dilatation may be present in addition to the finding of obstruction. In these instances, the diagnosis of bronchiectasis is often made, when in fact this is not a true bronchiectasis, but rather the secondary effect upon the bronchi from the obstruction below. A case of this type is shown in Figure 7. This patient had a typical bronchial asthma, but with an unusual amount of sputum which led to the diagnosis of possible bronchectasis. The first examination made in 1928 reveals the moderately dilated bronchi, but with characteristic occlusions of many of them at their peripheral end. The occlusions as shown in Figure 7*A* are rather marked and the rounded-off abrupt ending is characteristic of an actual plugging of the bronchial lumen. This patient was given a variety of treatments, including the introduction of iodized oil and treatment for allergy. Reëxamination six years later, as shown in Figure 7*B*, revealed a marked change in the character of the process. The patient's clinical symptoms have improved greatly in the interim and at this time there was relatively little expectoration. The bronchogram at this time shows the bronchial lumen to be closer to the normal in size and the degree of obstruction is very minimal. On the left side, there is very little obstruction; on the right, only a few of the bronchi, as shown by the arrow, show evidences of real occlusion. Changes in the appearance of the bronchi after treatment have been reported, particularly by Anderson,[1,2] and lead further to substantiate the theory that these findings are due to actual mucous plugs. Perhaps these are mechanically extended from the bronchi by the introduction of the iodized oil restoring the bronchial lumen to normal.

The reaction of the patient to the introduction of the iodized oil is often a very favorable one, as illustrated in the above case. Following the introduction of the oil, as has been pointed out by a number of investigators,[1,2,4,8] the patient may bring up large quantities of sputum containing numerous mucous plugs and a great sense of relief and improvement takes place. Our experience confirms this observation abundantly. Furthermore, reëxamination following this free expectoration may show bronchi whose lumina are wide open as compared to the partial or complete occlusion which was present prior to the introduction of the oil. This finding would seem to demonstrate more conclusively the occlusive nature of this lesion.

The introduction of iodized oil while the patient is suffering from an asthmatic attack or during the state which approaches a status asthmaticus may result in another type of reaction. The oil is propelled with great difficulty beyond the major bronchi. It may extend into the bronchi of the second or third bifurcation, but no matter how long the period of waiting, it will not extend beyond this point. In some instances of this type, the subcutaneous administration of epinephrine will facilitate the extension of the iodized oil into the more peripheral bronchi. This is not always the case, however, and the subcutaneous introduction of epinephrine in many of our cases did not promote any further extension of the iodized oil beyond the area of a true obstruction as illustrated in Figure 8. In this instance films were made at intervals after the introduction of the oil. The patient was suffering from severe dyspnea at the time of the examination with a rather extreme state of asthma, which had been present for many years. The film illustrated in Figure 8*A* was made fifteen minutes after the introduction of the oil, but the bronchi are very poorly filled out. It will be noted that in some instances the rounded-off appearance previously described and apparently characteristic of occlusion is well shown. In others, the oil ends abruptly and the column of air within the bronchi can be observed beyond the limits of the contrast medium. Figure 8*B* is

a reproduction of the roentgenogram made twenty minutes after the subcutaneous injection of 15 mm. of epinephrine, and it is evident that some relaxation of the bronchi took place as the oil passed out farther than before. The effect, however, was not marked and it will be noted that in the bronchi which showed the characteristic features of occlusion, no particular advance in the position of the oil was obtained. In

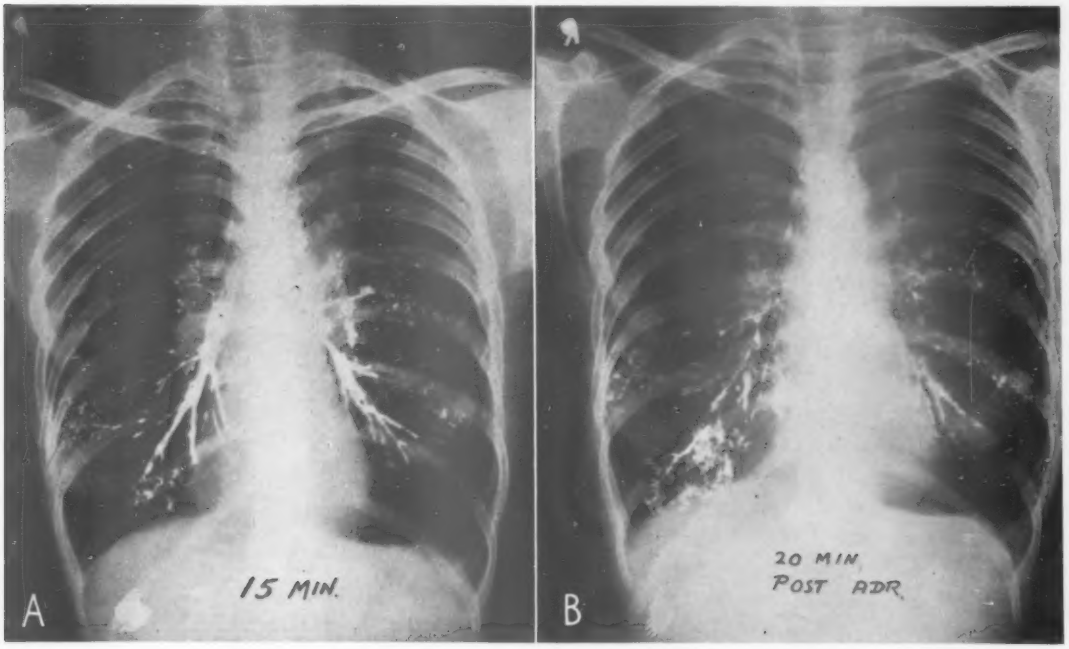

Fig. 8. Posteroanterior roentgenograms of chest after bronchography in a case of bronchial asthma with extreme symptoms. *A*. Roentgenogram fifteen minutes after introduction of iodized oil showing lack of progress through the bronchi due either to emphysema or spasm. A number of occluded bronchi, however, are shown on the right side. *B*. Same case twenty minutes after the injection of epinephrine. There has been some advance of the iodized oil, but the difference is not marked. The obstructed bronchi are still shown.

the majority of instances in our experience, the addition of epinephrine has had very little effect. Further studies of this point are being made as it is possible that, in this way, the exact rôle of the bronchial spasm may be determined.

While the findings described above appear to be quite characteristic of bronchial asthma, it should be noted that in other types of chronic pulmonary and bronchial disease, obstruction of the smaller bronchi may occur. Pathologically this is of a very different type in that the effect upon the bronchus is rather that of an infection constricting the bronchial lumen by infiltration of the bronchial wall than an occlusion of the lumen of the bronchus by mucous plugs. From the roentgenologic standpoint, however, differentiation may be somewhat difficult and the clinical findings must be utilized to assist in making a sharp distinction between the non-asthmatic types of bronchial occlusion, such as occur with pneumoconiosis, tuberculosis, syphilis, chronic nonspecific lung infection and chronic bronchitis, and the true allergic asthma.

It is evident from the descriptions above that the bronchographic demonstration of occlusion of the smaller bronchi in cases of bronchial asthma during life correlates rather well with the autopsy findings. These roentgen findings serve to indicate that the presence of mucous plugs in the bronchi is an integral part of the disease process in bronchial asthma, varying in

degree in different individuals and from time to time in the same individual. The demonstration of these occlusions may be an important factor in the prognosis of the individual case. In our experience those patients with bronchial asthma who have had extensive occlusions have in general been in the last stages of the disease. Nevertheless, in the very early cases, where the symptoms were relatively minor, some occlusion may also be met with.

SUMMARY

Bronchographic and pathologic studies give rise to a concept of bronchial asthma and the asthmatic attack as follows. The disease affects primarily the bronchial mucosa producing an enormous hypersecretion of mucous which accumulates within the lumina of the bronchi. Due possibly to stasis from spasm of the bronchial muscle to marked viscosity, or to other factors, this mucus forms a plug or core partially obstructing the bronchus so that air may be inspired past the occlusion, but is expelled much less readily. Emphysema is thus produced. During the asthmatic attack the spastic muscle clamps down around this plug, aggravating the occlusion.

Roentgen observation on living cases of bronchial asthma, by means of bronchography, demonstrates clearly the presence of these occlusive plugs during life and indicate that they are an integral part of the disease process in bronchial asthma.

Bronchography is of great value in elucidating the nature and extent of the process in individual cases and in giving some determination of the prognosis.

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EXPIRATORY ROENTGENOGRAMS FOR PULMONARY APICAL DETAIL*

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THE increasing popularity of collapse therapy in the treatment of pulmonary tuberculosis demands greater detail in roentgenograms than has previously been necessary. This is especially important in the apical and subapical areas of the lung in which are found the great majority of tuberculous lesions. The presence of even a minute infiltration or cavity may vary the course of therapy from simple bed rest to surgical measures such as pneumothorax, phrenicotomy or thoracoplasty. However, in the ordinary film small lesions are often difficult to visualize when located about the clavicular area. Such roentgenograms are usually made in the standard position of forced inspiration, arms at the sides or flexed at the hips, and in the posteroanterior view.

To reveal lesions situated beneath the clavicular shadow three modifications of the standard position have been proposed: (1) elevation of the arms overhead, (2) anteroposterior view, and (3) arms raised overhead, elevation of the tube and direction of the central ray 15 to 20 degrees caudally (Appelrath). These three methods act upon the sole principle of elevating the clavicles, and frequently produce the desired result. However, they are not entirely free from criticism. In the first place, raising the clavicle usually obliterates the extreme apex, and if a lesion extends from the extreme apex to the subapical area, elevation of the clavicle will obscure its upper portion. Secondly, elevation of the arms overhead is often accompanied by an elevation of the clavicle, chiefly in its lateral half; the medial half which usually covers the lesion may move very little. Thirdly, elevation of the clavicle is accompanied by elevation of the entire chest cage with possible distortion of the normal pulmonary relationships. In several cases we have observed calcifications which were subapical in the standard position become extreme apical when the arms were raised overhead (Figs. 1, 2, 3 and 4).

We wish to add another modification of the standard position to show apical detail. This method consists in taking roentgenograms during forced *expiration*. The principle here differs radically from that described previously in that the clavicle is *depressed* instead of elevated.

At the present time, roentgenograms taken during forced expiration are used under the following circumstances: (1) demonstration of small pneumothorax (Thompson and Barlow, 1922); (2) demonstration of atelectasis (Kreutzfuchs); the atelectatic shadow brightens when air is taken into the area during forced expiration; (3) to assist in localization of foreign bodies; (4) demonstration of certain interlobar abnormalities; (5) demonstration of mediastinal mobility during respiration; (6) demonstration of respiratory changes in the size of some pulmonary cavities.

The expiratory film has not been used to show pulmonary detail because of the common knowledge that during forced expiration the lung shows increased density, the heart is widened, the base of the lung is obliterated, and hilar shadows are distorted. Certainly such factors have made the expiratory film valueless for general lung pathology, but it has apparently escaped general attention that the apex is visualized clearly and in great detail. From the standpoint of apical density and detail there is practically no difference between expiratory and inspiratory films.

A few words regarding certain features

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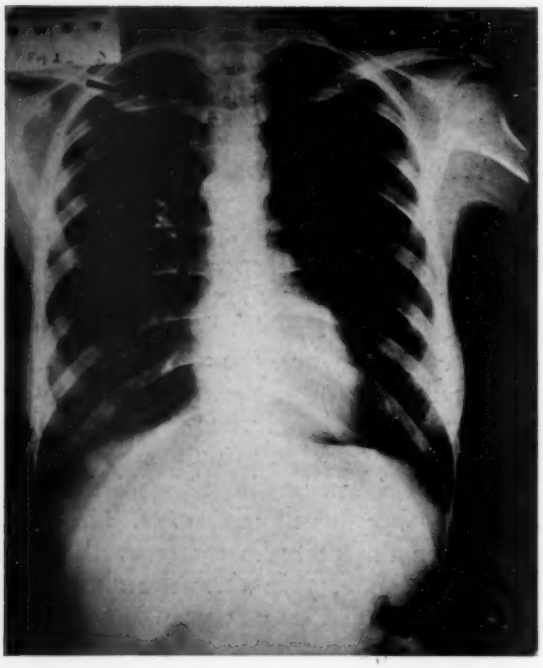

Fig. 1. Case 1. Film taken in standard position. Subapical calcification is hidden by the clavicle. Note its position opposite fourth dorsal vertebra.

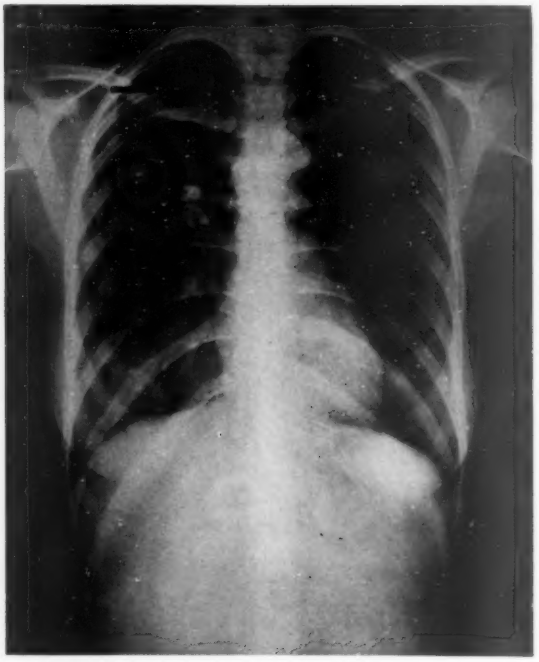

Fig. 2. Case 1. Film taken in standard position but with forced expiration. The calcification and the lung about it are in full view. The nodule is in the same position in the lung.

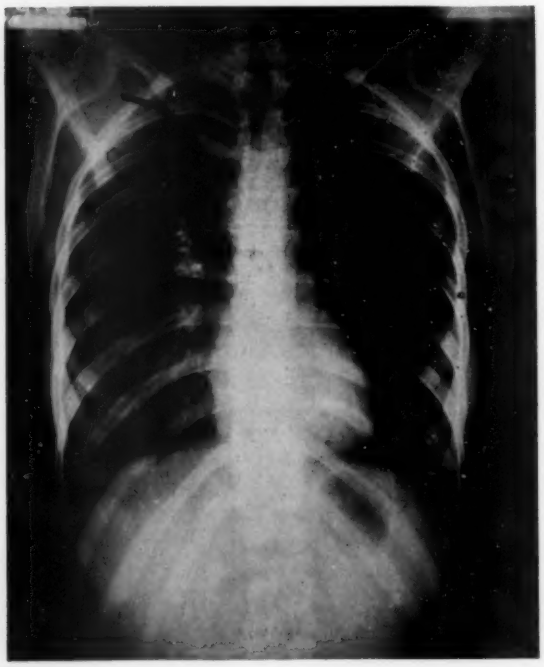

Fig. 3. Case 1. Position: arms overhead, forced expiration, posteroanterior view. The calcified nodule is partially hidden by the clavicle and has moved up to the level of the 3rd dorsal vertebra.

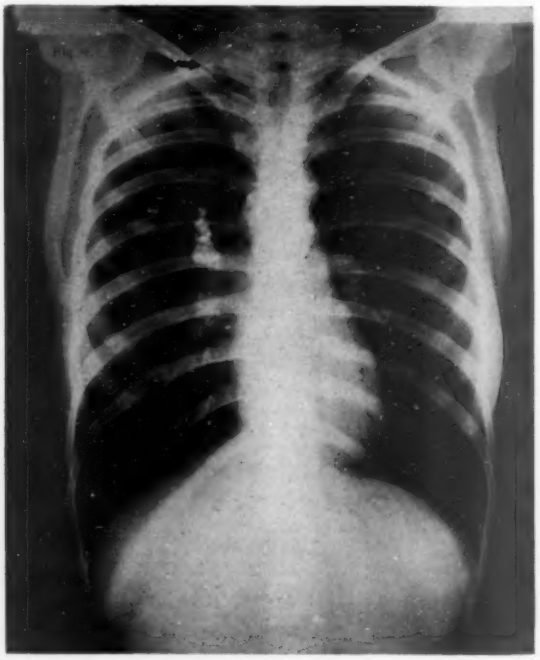

Fig. 4. Case 1. Position: arms overhead, inspiration, posteroanterior view. The nodule has moved up to the extreme apex and is at the level of the 2nd dorsal vertebra.

of the mechanics of respiration may help to explain the value of expiratory films. The act of inspiration is produced by contraction of the diaphragm and elevation of the ribs. There is also an elevation of the clavicle and scapula because the clavicle is attached to the bony chest cage through the sternum, and the scapula through the clavicle. The act of expiration is produced by ascent of the diaphragm and descent of the ribs, accompanied also by a lowering of the clavicle and the scapula. Thus, the inspiratory film shows a broad thorax, depression of the diaphragm, horizontal position of the ribs, high clavicle, and obliteration of the pulmonary apex. The expiratory film shows a narrow thorax, elevation of the diaphragm, increased obliquity of the ribs, low position of the clavicle, and a full view of the apex. The character of the clavicular motion is important. During respiration, the "upward and downward" movement of the clavicle is greater in its medial half than in its lateral half, and it is significant that only the medial half of the clavicle covers the lung. This inequality of motion is due to the fact that its medial connection is with the sternum which moves together with the ribs, while its lateral connection is with the scaqula which is bound to the chest cage posteriorly and indirectly.

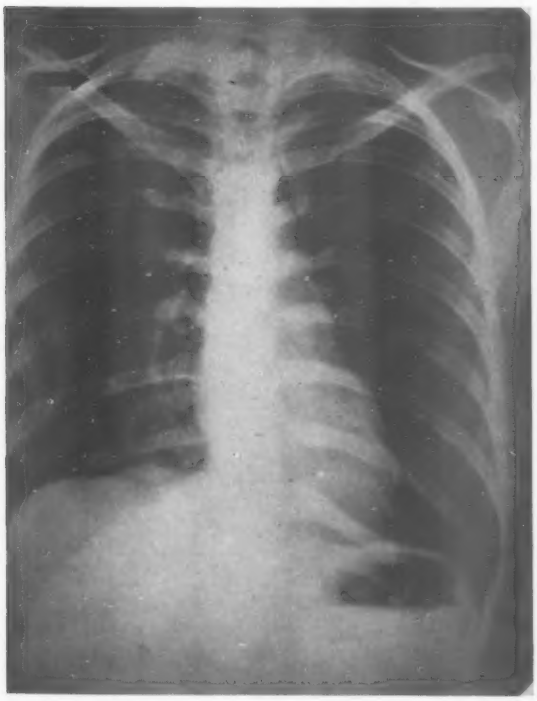

Fig. 5. Case 11. Standard position. The lesion at the right apex is hidden by the clavicle and does not present good detail.

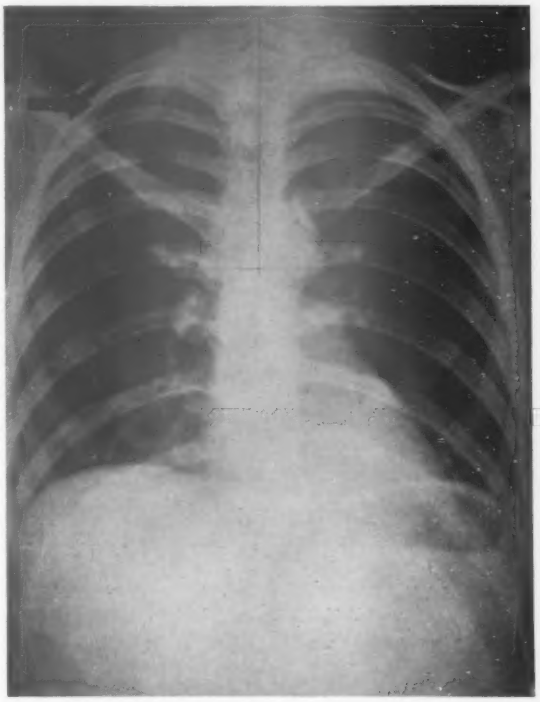

Fig. 6. Case 11. Standard position plus expiration. Note detail of apical lesion and amount of lung above clavicle.

The roentgenogram taken during forced expiration shows a low position of the clavicle, good apical detail, and a greater area of lung above the clavicle than seen on an inspiratory film. The technical roentgen factors are the same for inspiratory and expiratory exposures, with only an occasional need for a slight increase in voltage. In the adult, the clavicle shows a range of motion from 1 to 2 cm. between forced inspiration and expiration, with the extreme measurements ranging from 0.5 to 3 cm. This motion is of great value in disclosing lesions extending from the extreme apex to a point beneath the clavicle when the film is taken in the standard position,

Fig. 7. Case III. Position: arms overhead, inspiration, anteroposterior view. This position produces the greatest elevation of the clavicle, obliteration of the extreme apex, and a clear subapical area.

for during forced expiration the clavicle is lowered and exposes a greater area of lung above it. The clavicular motion is often unequal on the two sides, depending chiefly upon the motion of the ribs (Figs. 5 and 6).

Good clavicular motion is present not only in the normal chest but also in lungs showing extensive disease. The amount of clavicular movement does not depend at all upon any disease within the chest cage, but solely upon the bony thorax itself. Thus, considerable clavicular motion is present in many cases of pleuritis, pleural effusion, all types of pulmonary disease, and after phrenicotomy, pneumothorax and thoracoplasty. Poor clavicular motion occurs only in a few cases and under definite circumstances such as gross diseases of the bony thorax or clavicle restricting its motion; localized or generalized fixation of the bony thorax, as found in fibrous retraction of the chest cage or acute pleuritis; and in cases where the chest cage is fixed in extreme inspiration, as found in severe emphysema, asthma, and tension pneumothorax. The amount of motion of each clavicle depends upon the conditions existing in each hemithorax.

The lowering of the clavicles during expiration occurs in all positions or combination of positions, namely, anterior or posterior views, arms at sides or overhead, and Appelrath's modification. We have discarded Appelrath's position entirely, because we have found it inferior to the other methods. From the standpoint of apical detail we have divided the technical factors into three groups: (*a*) position of the arms, namely, overhead or at sides; (*b*) phase of respiration, namely, forced inspiration or forced expiration; (*c*) posteroanterior or anteroposterior views. The factors producing an *elevation* of the clavicle and resultant obliteration of the extreme apex, in order of importance, are: arms held overhead, forced inspiration, and an anteroposterior view. The factors producing a *depression* of the clavicle and a full view of the extreme apex, in order of

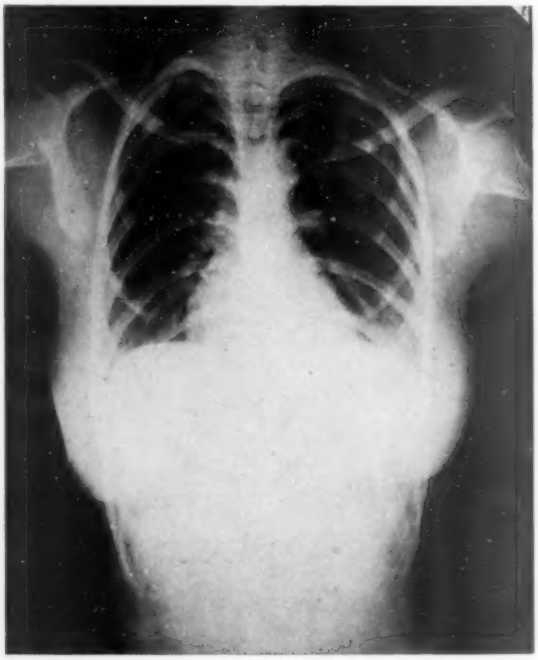

Fig. 8. Case III. Position: arms at sides, expiration, posteroanterior view. This position results in a maximum depression of the clavicle, a clear apex, and the greatest amount of lung above the clavicle.

importance, are: arms held at sides, forced expiration and a posteroanterior view.

To obtain the highest clavicular rise in order to disclose the subapical area one should use the posture of arms overhead, forced inspiration, and anteroposterior view. To obtain the lowest clavicular position to show the extreme apex one should use the posture of arms at sides, forced expiration, and posteroanterior view. The clavicle shows a range of motion of 3 to 5 cm. between these two positions. Six other postures which result in intermediate locations of the clavicle are possible, namely: (1) arms overhead, inspiration, posterior view; (2) and (3) arms overhead, expiration, anterior and posterior views; (4) and (5) arms at sides, inspiration, anterior and posterior views; (6) arms at sides, expiration, and anterior view. In routine work where it is desirable to remove the clavicular shadow, as found in a film made in the standard position, additional films are taken in other positions determined by the necessity to raise or lower the clavicle (Figs. 7 and 8).

SUMMARY

Roentgenograms taken during forced *expiration* show a depression of the clavicles and expose a greater area of the pulmonary apex than can be obtained in films taken during forced inspiration. Together with other methods, the entire upper third of the lung can be visualized with great detail and free from the clavicular shadow.

ROENTGENOSCOPIC LOCALIZATION OF TUBERCULOUS LESIONS OF THE LUNG FOR THE BEST ROENGENOGRAPHIC REPRODUCTION*†

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THE roentgen ray has marked a direct course to early diagnosis, to accurate interpretation of pathogenesis and to better treatment of tuberculosis. However, experience has clearly demonstrated that certain circumstances inject inaccuracies into the information which chest roentgenography supplies. The conventional single film used within the strictest limits of economy necessary in most public sanatoria today is one source of misinformation which, strangely enough, we endure with the greatest complacency. This major imperfection in chest roentgenography is occasioned by certain physical principles uncontrolled within the stock technique of producing these single posteroanterior negatives.

Roentgenographic interpretation of the tuberculous lung has to do with size, localization and character of foci and structures. Of these three chief requirements, not one is adequately cared for by the single negative. Sizes are given only in the caudocephalad and mediolateral dimensions;[1] localization is similarly incomplete, and focal characteristics may not be clearly revealed in that excavation is not demonstrated with moderate frequency when present. These are major defects and require some means for their correction if the best diagnosis and treatment are obtained.

When stereoscopic views are used or, as preferred by Dunham, double stereoroentgenograms of both obliques, these hazards are reduced. A combination of posteroanterior and lateral views is of assistance. Both of these techniques reveal focal or structural changes, the patency of cavity or other menacing changes to the unsuspecting user of conventional single films.

Being energy, roentgen rays are therefore dissipated by distance and by matter in proportion to its mass and radiolucency. In other words, any structure placed between a roentgen tube and a film and having some degree of radiolucency will be effectively penetrated by the rays in direct proportion to its distance from the tube and its radiolucency. Acquainted with this fact, it is easily seen that the matter of distance and radiolucency can operate to a disadvantage in that structures placed near the tube and having a high radiolucency may be completely penetrated and fail to be silhouetted on the film. Similarly, if structures of higher radiopacity are placed near the film incomplete penetration occurs with poor reproduction. The well-known physics of roentgen rays operate to these ends.

A practical application of these principles in chest roentgenography will clarify the problem of accurate reproduction of chest pathology on single films. Accordingly, thin-walled cavities situated in the posterior lung periphery may be completely penetrated and therefore not reproduced on the film. Cavity, similarly located and having depth and structure capable of being projected, may be curtained off by radiopaque atelectatic parenchyma or inflammatory deposit with failure to reproduce. These illustrative circumstances are only two of many under which single chest roentgenograms may be misinformative. Paracardiac and soft parenchymal deposits, mediastinal nodes, localized pneumothoraces, and exudates of the interlobar fissures, pleural or posterior diaphragmatic

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† Appreciation is expressed for the assistance of Dr. Stephen A. Douglass, Superintendent of Valley View Sanatorium, Paterson, New Jersey.

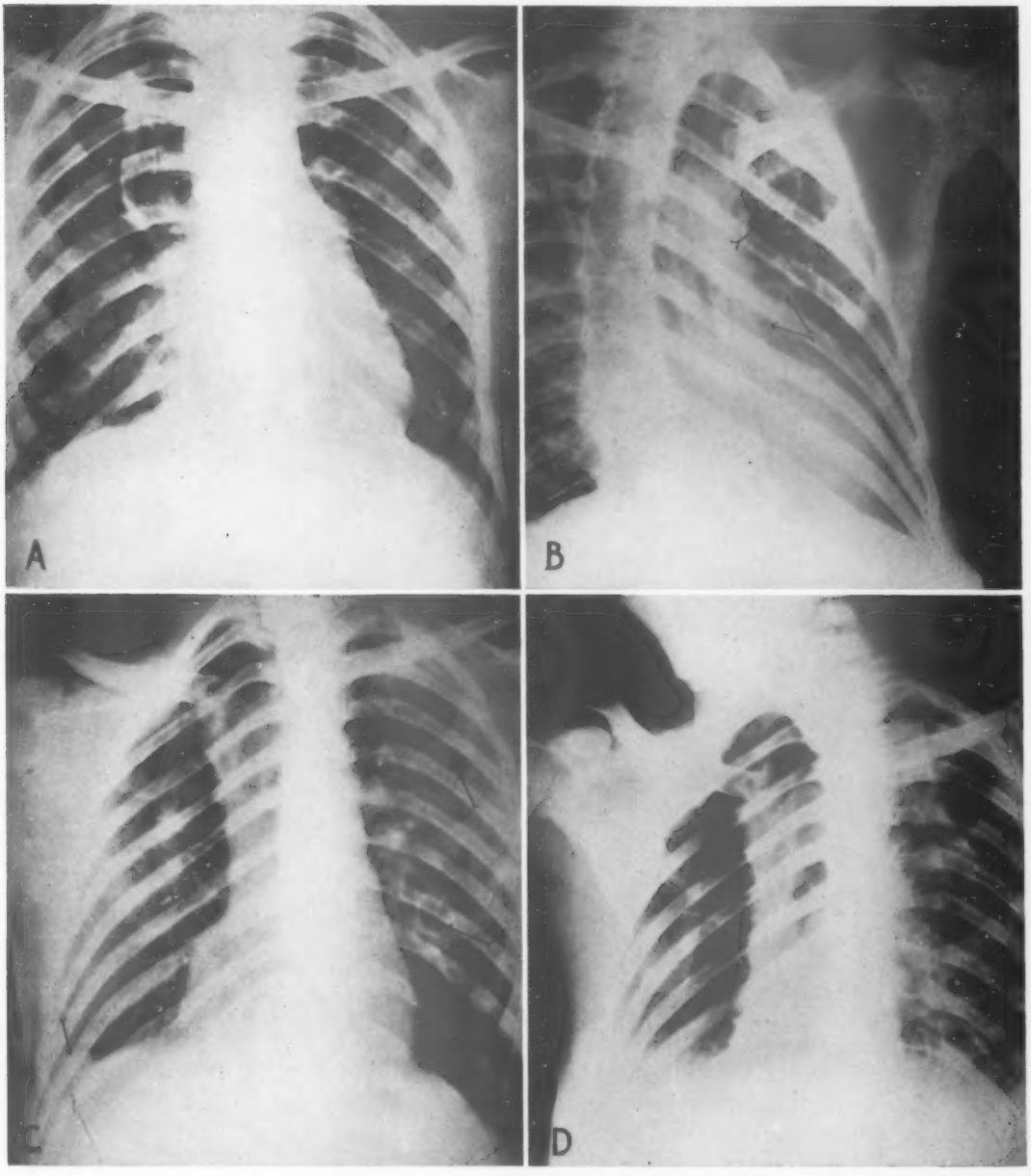

Fig. 1*A*. Conventional posteroanterior view of a chest in which a right-sided selective artificial pneumothorax is present. Sputum positive. Cavity is not clearly demonstrated contralaterally.

Fig. 1*B*. A right anterior oblique view demonstrated cavity in the pulmonary apex. The questionable shadow in the hilum was not cavity.

Fig. 1*C*. Sharp left anterior oblique view revealed retrocardial cavity. A pleural fibrous ball was present in the right posterior diaphragmatic sulcus although not visualized in the posteroanterior view (Fig. 1*A*).

Fig. 1*D*. Artificial pneumothorax has been instituted on the left revealing more clearly both cavities.

spaces comprise other pathological processes which may not appear on the single film and for reasons contained within the principle that roentgen rays are dissipated by distance and matter.

The importance of views at multiple

angles, or, more specifically, at the most informative angles, to correct defects encountered in the use of single films, finds expression in the work of Stivelman,[2] who observed that exudates in the interlobar fissures may be interpreted either as inflammation or tumor of the lung parenchyma unless roentgenographed at an angle which outlines the narrowed opacity of these fluid collections. Korol and Scott[3] found that small pleural effusions and residual pneumothoraces remained longest in the posterior diaphragmatic sulcus and were best demonstrated in the lateral recumbency or knee chest position. Ellison[4] pointed out the importance of both anterior and posterior oblique views of the hemithorax for the demonstration of adhesions. In conjunction with these observations, it is worth noting that in 1935 the Committee on X-ray Apparatus and Technique of the American Sanatorium Association ably headed by McPhedran, stressed the importance of multiple angles for general observation and "rotated exposures in order to throw the common sites of infiltrations clear of the cardiac contour." The committee had in mind that the problem for every physician treating tuberculosis is an accurate diagnosis, choice of treatment and periodic observations of focal change, and that this problem, covering as it does the entire contact with the patient, should be met accurately. Recommendations on new equipment were made including the rotating anode tube for its fine focus and the combined use of the pulse relay and Wilsey high-speed Potter-Bucky diaphragm.

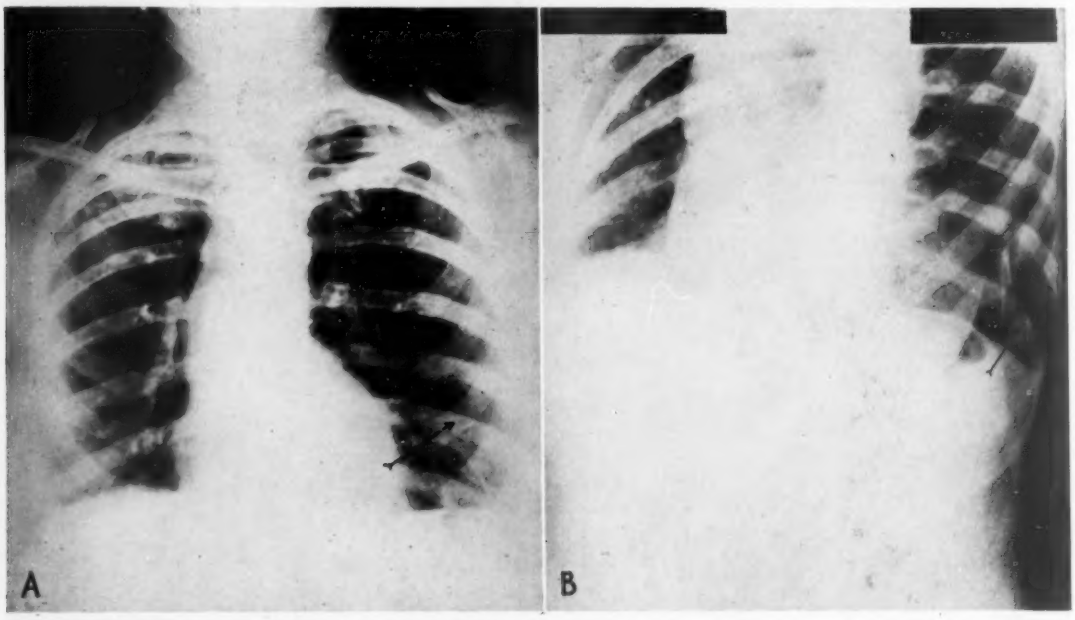

Fig. 2*A*. Conventional posteroanterior view does not reveal the presence of air in the left pleural space.
Fig. 2*B*. Sharp left anterior oblique view demonstrates the presence of pneumothorax.

The modern roentgen unit combining roentgenoscopy and roentgenographic exposure offers the maximum advantage to a sanatorium staff because film production can be secured without change of position after the most informative angle is determined.

The use of roentgenoscopy for a more accurate investigation of chest pathology is used by most of us. By this means and at a minimum expense multiple views are secured, the mechanics of respiration studied and structural variations seen. Roentgenoscopic study of the tuberculous lung for cavity alone is indicated for its greater accuracy. Insufficient attention

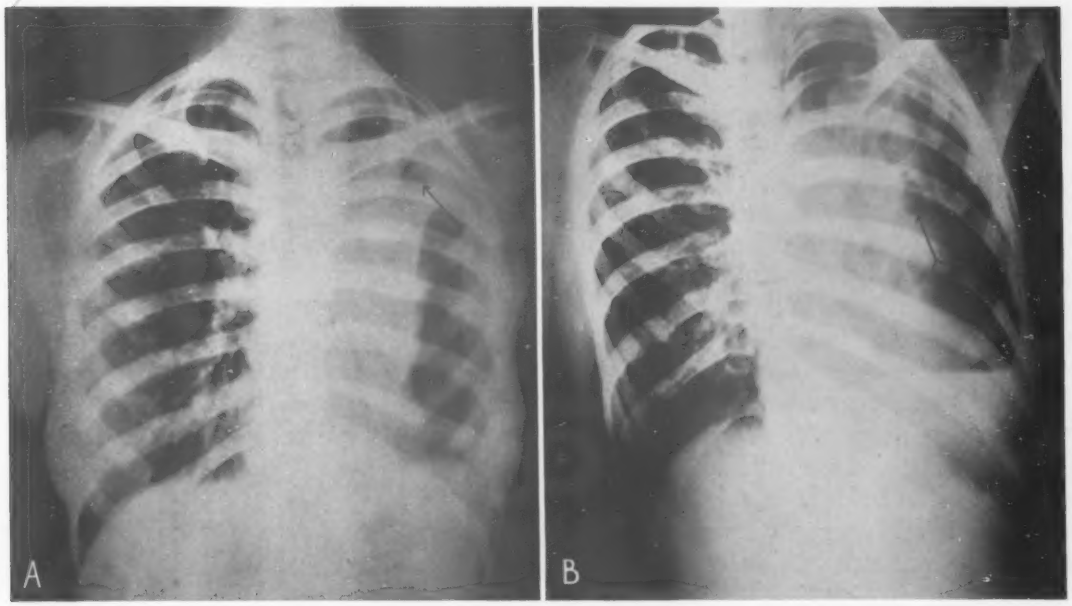

Fig. 3*A*. Misinterpretation of cavity as indicated may occur from this posteroanterior view.
Fig. 3*B*. A right anterior oblique view demonstrates cavity at a lower site and the presence of a moderate pleural effusion.

may be given to the fact that cavity becomes more distinct on deep expiration and that diameters may vary with the cycle of respiration. What is more, the pneumothorax lung has greater change in volume with the cycle of respiration than the thoracic wall surrounding it, and the flexible mediastinum has its greatest displacement at the end of expiration. This latter is of significance in that a flexible mediasti-

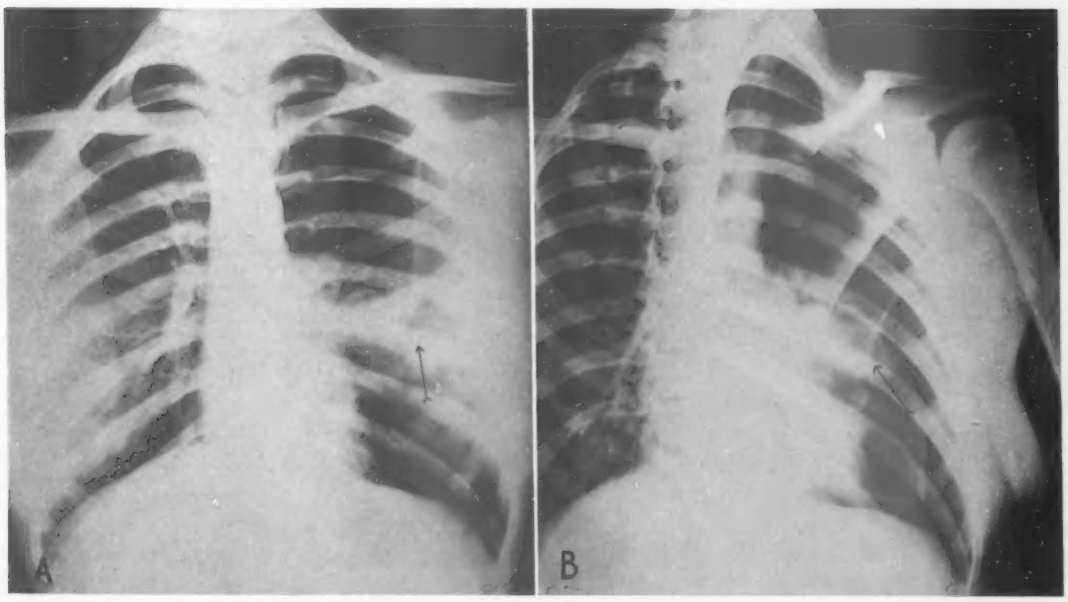

Fig. 4*A*. Left-sided artificial pneumothorax is present but neither the cavity nor the character of adhesions is revealed. The sputum was positive.
Fig. 4*B*. When roentgenographed in the extreme right posterior oblique these defects were corrected.

num accounts for obscure anoxemia in some pneumothorax patients.

When to this list of advantages of roentgenoscopy is added film records of the most informative views, the use of the roentgen ray in study of the chest reaches its maximum value. An opportunity is afforded to secure permanent records for future comparison of focal or structural change, regardless of the location, which, after all, bears as close relation to successful phthisiotherapy as does comparative focal or structural changes seen on the posteroanterior roentgenogram.

In the sanatorium where system rules, the conventional single film conveys misinformation frequently enough to make roentgenoscopic localization of obscure lesions before roentgenographic reproduction routine. But if one is to use multiple angle views, it should be done with thought and a purpose. It is not enough to request an oblique or lateral view any more than it is to request the conventional posteroanterior view. Good usage would eliminate these terms because there is no fixed position for the best roentgenography of chest pathology on single films other than the one predetermined by roentgenoscopy.

The method only consists of locating the most informative angle with the roentgenoscope and duplicating this position at the plate-changer, after which the roentgenogram is produced. Winged scapula, elevation or lowering of a clavicle or mammary gland, or rotation of the thorax on its perpendicular axis may in specific instances be so slight as to appear insignificant but it is just this variation from the ordinary that reveals clearly the essential details.

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MAGNESIUM TETRAIODOPHENOLPHTHALEIN IN ORAL CHOLECYSTOGRAPHY*

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EARLY in our experience with the intravenous method of cholecystography[1] in 1924 an unfortunate incident occurred which emphasized the desirability of a safer way of administering cholecystographic media. Believing that the safety of mechanisms in the gastrointestinal tract offered a measure of protection, one of us resorted to self administration of sodium tetrabromophenolphthalein by the oral route. A satisfactory cholecystogram was obtained and that marked the beginning of the oral method of cholecystography which we introduced in 1925.[2,3,4]

After a period of debate regarding the relative merits of the two methods of administration, the oral route was generally accepted as usually preferable. This was due to its safety and a wider field of applicability.

Many substances have been tried in cholecystography, Graham, Cole and Copher[5] having originally tested salts of 48 chemical compounds. For one reason or another, their use has been abandoned in favor of the sodium salt of tetraiodophenolphthalein. This dye, however, is irritating to the gastrointestinal tract and produces mild toxic symptoms. Many patients experience nausea, vomiting, diarrhea, or a combination of these symptoms, after its ingestion. Because of this fact they are frequently reluctant to take it.

With this in mind we, during the past two years, made and examined for desirability calcium, lithium, potassium and magnesium salts of tetraiodophenolphthalein. Because of low solubility or impalatability and irritating or toxic qualities all were rejected except a magnesium salt. We produce this substance by converting the sodium salt of tetraiodophenolphthalein to insoluble acid tetraiodophenolphthalein by acidifying it in watery solution with an excess of hydrochloric acid. The precipitate is washed thoroughly with distilled water. It is then treated with a slight excess of magnesium oxide in distilled water. The supernatant fluid is filtered and evaporated to dryness. The resulting dye is a light blue crystalline compound. It is less soluble in water than the sodium salt of tetraiodophenolphthalein and practically tasteless. In a brief clinical trial it has proved gratifyingly superior to the sodium salt.

The dye has been administered in water and in capsules. The latter method has not been satisfactory, however, because of failure of the substance to go completely into solution in the intestinal tract. This objection can probably be easily overcome by proper blending of the dye with a suitable vehicle to prevent pooling of the powder. Because it is practically tasteless there has been no objection to drinking it in solution. Some patients have preferred adding sugar and vanilla to flavor and disguise the slight odor common to drugs. When given either in liquid or capsules the dose has been administered in three equal parts given at half hour intervals. If liquid is used a 6-ounce glass of water is adequate for each portion though not sufficient to dissolve the dye completely.

Administration may be by any of the methods now in use for the sodium salt of tetraiodophenolphthalein. In our own work, however, we have preferred and in most cases used a single dose immediately following a light evening meal containing some fat. Films have been taken at fourteen, sixteen and eighteen hours, with a

* Read at the Fifth International Congress of Radiology, Chicago, Ill., Sept. 13–17, 1937.
† Deceased.

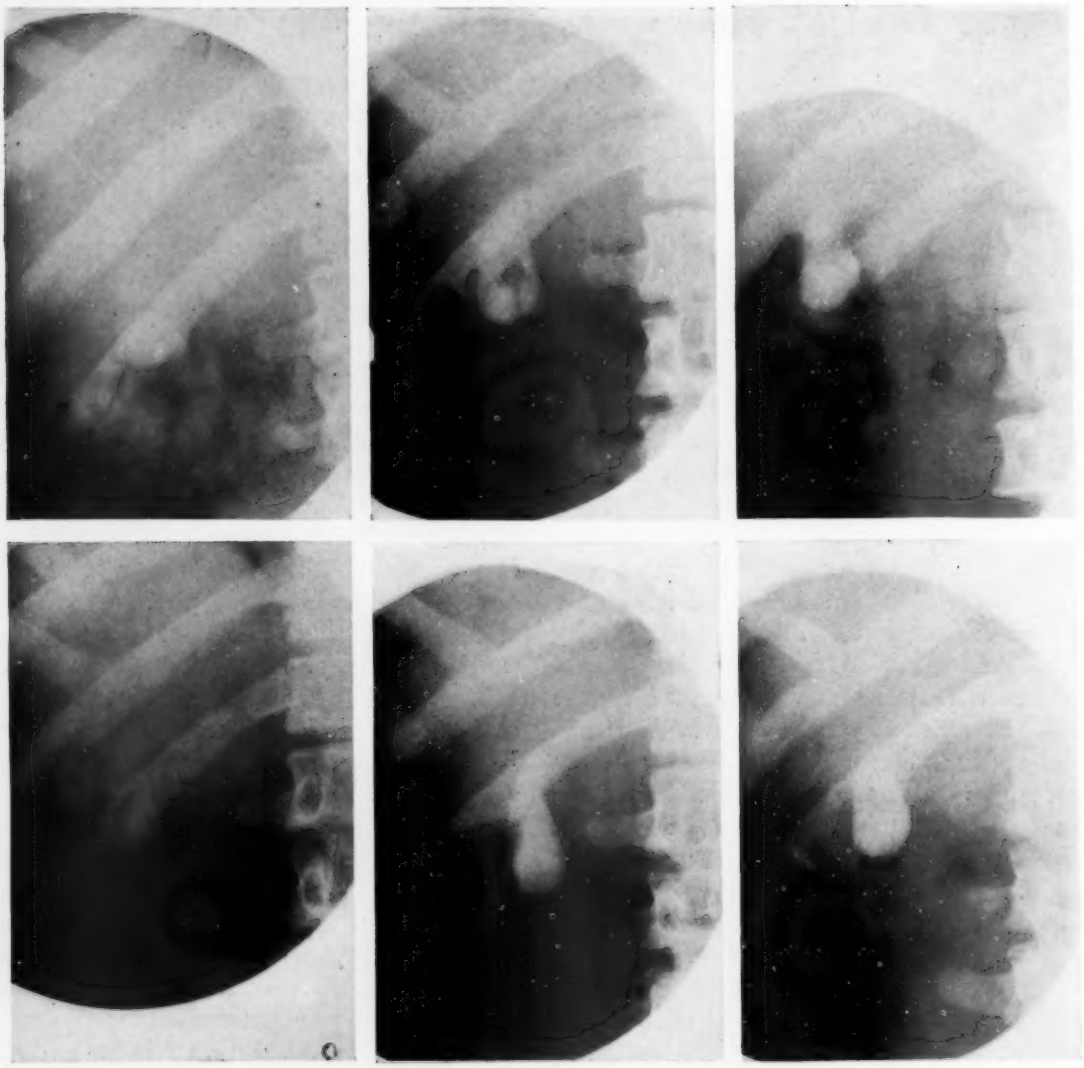

Fig. 1. Cholecystograms of a patient at fourteen (above) and sixteen (below) hours after taking 3, 5 and 7 grams of magnesium tetraiodophenolphthalein. The increase of shadow density (from left to right) corresponds to the increase in the amount of dye administered.

fat meal between the sixteen- and eighteen-hour films. This single dose method has the advantages of simplicity, hence wider applicability, and conservation of time and material. It is less disturbing to the patient's dietary habits than multiple dose methods and because of the shorter time interval many foreign factors which may influence filling or emptying are avoided. Moreover, the method ordinarily enables one to secure shadows of good diagnostic grade.

The dye has been given both before and after the evening meal. In every instance where the two were compared on the same patient the shadows from administration after the meal were superior. In all probability the increased alkaline medium in the intestinal tract following the taking of food acts to keep the dye in solution and hence in an absorbable state.

The magnesium salt of tetraiodophenolphthalein has been tried in doses ranging from 3 to 7 grams. Over this range there is produced a progressive increase in the density of roentgen shadows of the gallbladder

(Fig. 1). It appears, perhaps due to its lower solubility, that a 5-gram dose gives a shadow of about the same density as a 3.5-gram dose of the sodium salt of tetraiodophenolphthalein (Fig. 2). We believe that the dose can be standardized at 4.5 to 5 grams for shadows of optimum diagnostic density.

The chief superiority of the magnesium salt of tetraiodophenolphthalein lies in its palatability and in the greatly reduced number and severity of symptoms experienced by those who take it. Table 1 shows that of the 25 patients who took both dyes 19, or 76 per cent, had no symptoms whatever with the magnesium salt of tetraiodophenolphthalein, whereas 3 ,or 12 per cent, had no symptoms with the sodium salt of tetraiodophenolphthalein. After taking the magnesium salt 4, or 16 per cent, were nauseated, 1, or 4 per cent, vomited and 2, or 8 per cent, had diarrhea. After taking the sodium salt 24, or 80 per cent, were nauseated, 6, or 26 per cent, vomited and 3, or 12 per cent, had diarrhea. It should be noted, moreover, that the nausea ex-

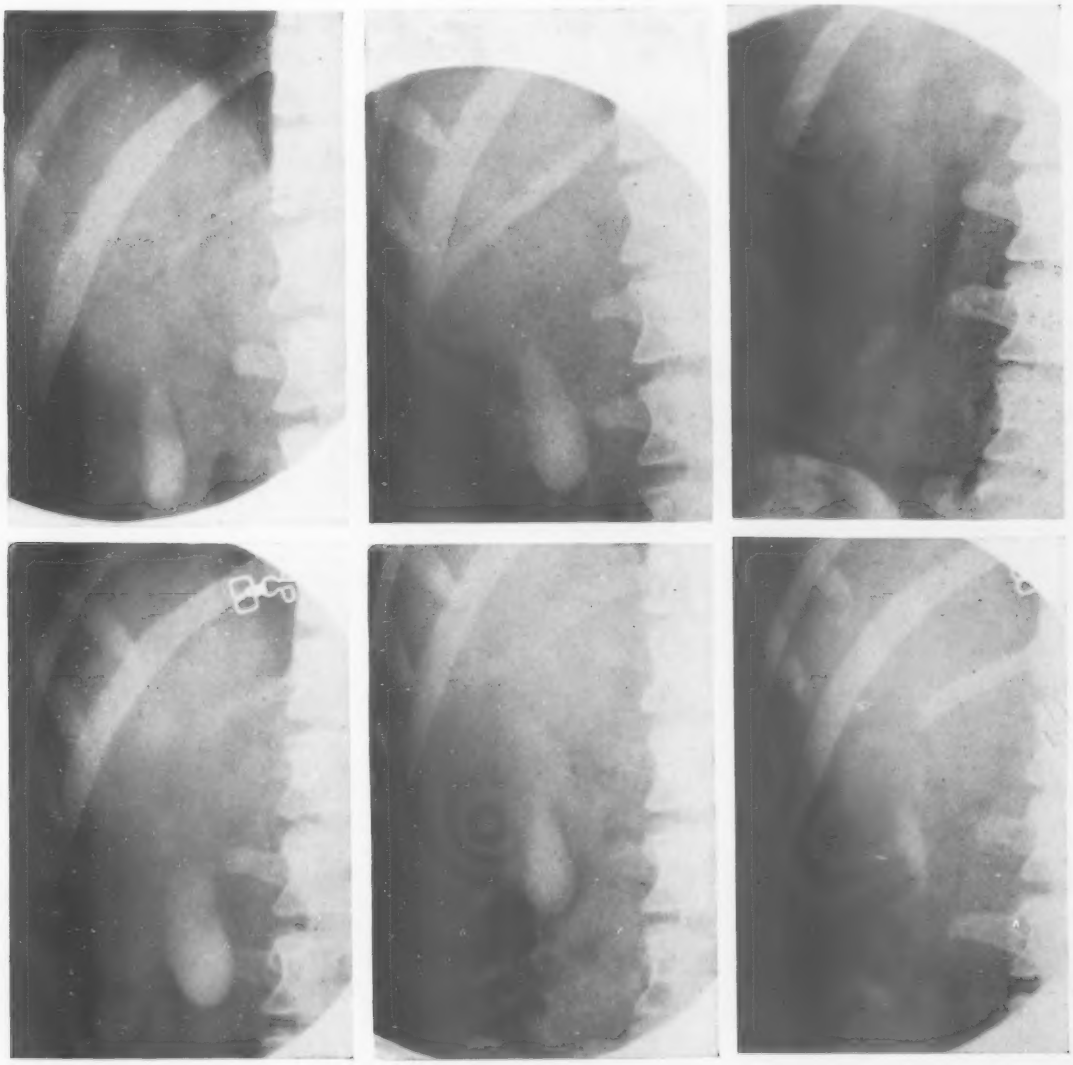

Fig. 2. Cholecystograms of a patient at fourteen, sixteen and eighteen hours after taking 3.5 grams of sodium tetraiodophenolphthalein (above) and 5 grams of magnesium tetraiodophenolphthalein (below) are of about equal density.

TABLE I

COMPARISON OF SYMPTOMS IN A SERIES OF CASES TAKING BOTH THE MAGNESIUM AND SODIUM SALT OF TETRAIODOPHENOLPHTHALEIN

	Magnesium Tetraiodophenolphthalein		Sodium Tetraiodophenolphthalein	
	Number	Per cent	Number	Per cent
Cases	25		25	
No symptoms	19	76	3	12
Nausea	4	16	20	80
Vomiting	1	4	6	24
Diarrhea	2	8	3	12

perienced by a few after taking the magnesium salt was of a minor grade in practically every instance.

In comparing the symptoms in the first 100 cases with a total of 111 administrations of magnesium tetraiodophenolphthalein with 2,368 consecutive administrations of sodium tetraiodophenolphthalein using several methods, the comparison is likewise strikingly favorable to magnesium tetraiodophenolphthalein, as is shown by Table II.

After taking the magnesium salt of tetraiodophenolphthalein 83, or 77.4 per cent, were symptom-free; 18, or 16.2 per cent, were nauseated; 4, or 3.6 per cent, vomited, and 11, or 9.9 per cent, had diarrhea. After taking the sodium salt of tetraiodophenolphthalein 1,021, or 43.1 per cent, were without symptoms; 701, or 29.6 per cent, were nauseated; 445, or 18.7 per cent, vomited, and 386, or 16.2 per cent, had diarrhea. No other evidence of irritation has been observed, and no toxic symptoms have been experienced with the magnesium salt of tetraiodophenolphthalein. With the sodium salt of tetraiodophenolphthalein headache, vertigo, chills and abdominal cramps have occasionally been noted.

TABLE II

COMPARISON OF SYMPTOMS IN TWO SERIES OF CASES, THE ONE TAKING THE MAGNESIUM AND THE OTHER THE SODIUM SALT OF TETRAIODOPHENOLPHTHALEIN

	Magnesium Tetraiodophenolphthalein		Sodium Tetraiodophenolphthalein	
	Number	Per cent	Number	Per cent
Administrations	111		2,368	
No symptoms	83	74.7	1,021	43.1
Nausea	18	16.2	701	29.6
Vomiting	4	3.6	445	18.7
Diarrhea	11	9.9	386	16.2

SUMMARY

1. A method of preparing a magnesium salt of tetraiodophenolphthalein is given.

2. It appears from results obtained in a preliminary trial that it is superior to media at present in use for oral cholecystography.

3. Its chief distinguishing qualities are palatability, minor irritating effects on the gastrointestinal tract and freedom from toxicity in amounts employed in clinical work.

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CALCULI IN THE SEMINAL VESICLES

REPORT OF CASE

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THE presence of calculi in the seminal vesicles is always a rare and noteworthy occurrence. The spectacular arrangement of the stones, which appear in the roentgenogram as a beaded necklace twisted upon itself, provides the feature of interest in this report.

S. V., male, aged forty-seven, was referred to me, in November, 1934, because of nocturia, nycturia, dysuria, hematuria and inability to empty the bladder. His symptoms began two years ago with nocturia, which has become progressively worse until at present he must get up five or six times at night, and during the past five months nycturia has occurred almost every night. Also, there is difficulty in starting a stream, a lack of force, and two days ago blood was noticed in the urine.

The only significant fact in his past history is a duodenal ulcer, complicated by four attacks of hemorrhage which responded to medical treatment each time.

Physical Examination. The general examination is not important and only the urological findings are given. The external genitalia are normal. The rectal examination revealed a prostate smooth, firm and not much enlarged; the seminal vesicles full and indurated. When the bladder was catheterized, 10 ounces of residual urine was obtained; this was confirmed by several examinations.

In the *cystoscopic* examination no stones, tumors nor diverticula were observed, and both ureteral orifices appeared normal. There was a generalized cystitis. From bladder neck to the veru, no obstruction could be seen to account for the patient's retention of urine.

Although the neurological examination was essentially negative, it was the opinion of the neurologist that this residual urine was caused by a disturbance of the nerve supply to the bladder.

Laboratory Findings. Blood: blood pressure, 130/78; hemoglobin, 78 per cent; white blood cells, 18,000; red blood cells, 3,950,000; blood chemistry: total non-protein nitrogen, 73.4; creatinine, 2.9; Wassermann reaction was negative. Spinal fluid, normal. Urine: albumin, 1+; white blood cells, 560; and red blood cells, 20 per cubic centimeter; culture, *B. coli.*

Roentgen Findings. A plain roentgenogram of the urinary tract revealed calculi in the prostate and the unusual arrangement of shadows in the seminal vesicle as shown in Figure 1. The excretory pyelograms gave no visualization of the kidneys, but in the last film appeared a normal bladder outline.

FIG. 1. Roentgenogram (retouched) showing calculi in seminal vesicles.

Subsequent Course and Treatment. Because of the renal insufficiency, this patient was treated with an indwelling catheter, and although the drainage has been continuous over a period of two years, the non-protein nitrogen has ranged from 73.4 to 108; creatinine from 2.9 to 6.5, and urea nitrogen from 49.5 to 66. He still has 6 ounces of residual urine. His general health, however, has been good enough to permit him to carry on his daily business as a broker. No attempt has been, nor will be, made to correct surgically the neurogenic disturbance of the bladder, and since the calculi in the seminal vesicles are not the cause of his symptoms they will not be removed.

DISCUSSION

The opinions concerning the etiology of calculi in the seminal vesicles are as numerous as the authors writing on the subject. According to some, the stones develop because of stagnation, poor drainage and infections. Others observed that the concretions form around spermatozoa. Young states that the most common causes of calcification in the seminal vesicles are tuberculosis or other chronic inflammations.

The symptoms vary and may be quite interesting. Perineal ache, painful coitus, priapism, frequency, dysuria and even hematuria are recorded. For instance, 2 patients reported by Vaughan had hematuria. At other times the stones may produce atypical complaints. Such were the complaints of a patient observed by James and Shuman in whom the symptoms were similar to those of renal calculi; the right kidney was operated upon but no calculi found. At autopsy the right seminal vesicle contained four stones.

The majority of patients who have calculi in the seminal vesicles, however, do not have symptoms and the stones are found only at necropsy.

The size of the stones varies from that of a buckshot to that of a cherry stone. Belfield contends that organic concretions with lime salts not exceeding the size of the former are not uncommon, but larger ones are unusual. In numbers, a very few up to 157 in Beyer's patient, or 200 as reported by Albers have been found. The chemical analysis reveals calcium phosphate and carbonate in the majority of examinations.

The diagnosis is usually made from the roentgenogram; more rarely from the rectal examination.

When aggravating symptoms are present surgical treatment may be necessary, but quiescent calculi, as in the patient reported, should not be disturbed.

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RHYTHMIC CYCLIC ALTERNATING ACTIVITY OF THE KIDNEYS AND RHYTHM OF OTHER ORGANS IN GENERAL

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THE accompanying series of roentgenograms (Figs. 1, 2, 3, 4, 5 and 6) demonstrates the principle of rhythmic activity of the kidneys in particular. In 1933, after a study of several cases of excretory pyelography, I came to the conclusion that there is an alternating rhythmic activity of the kidneys. This observation was incorporated in the Annual Administration Report for the year 1933 of the Barnard Institute of Radiology, Madras. It was then noted, in a few cases where intravenous pyelography was carried out, that an alternating cyclic action of the kidneys existed, the right kidney concentrating the iodine salt while the left excreted a proportionately greater amount of salt, and vice versa. A phase of subdued or basal activity goes on in one kidney while, in the other, a phase of accelerated secretion predominates. This alternating cyclic action, which has been noted to take place every fifteen to twenty minutes, varies considerably in different individuals and is more marked in those with an increased basal metabolic rate. Further work along these lines is being carried out in cases of exophthalmic goiter and myxedema.

Forsgren has shown (see Editorial Review in the *British Medical Journal* of October 12, 1935, regarding the subject of rhythmic body functions) that a diurnal rhythmic activity obtains in the liver by estimating glycogen content at different periods and also by the amount and character of bile in the gallbladder showing diurnal rhythm.

That the demonstration of this rhythmic activity of the liver is within reach of roentgenologists is shown by the fact that in a series of roentgen examinations carried out by me in this Institution it was noted that roentgenograms of the liver showed alternating periods of increased and decreased density.

In addition to the periodic variability in density in the kidneys and the liver (as noted in the roentgen examination) the rate of excretion in the former as seen in the roentgenoscopic examination and the corresponding variability of the size of the gallbladder after "stipp" administration in the latter confirms the periodic rhythmic activity of these organs.

Considering that there is a periodical dilatation and contraction of the spleen and of the gallbladder and periodic activity of several organs of the body, some with bilateral representation, e.g., ovaries, testes, mammary glands, etc., one is led to believe that this rhythmic activity is a general property of each organ and of all the organs as a whole. The alternating action of the respiratory system wherein there is greater flow of breath through one nostril compared with that through the other, corresponding to the change of side of a sleeping person, which changes appear to occur about every forty minutes, also confirms the rhythmic activity of the organs of the respiratory system. I am quite sure that further experiment will demonstrate that this rhythmic activity is a universal factor in the animal kingdom.

Acknowledgments are made to Captain T. W. Barnard, Director, the Barnard Institute of Radiology, Government of Madras, and to Colonel M. M. Cruickshank, I.M.S., Surgeon, Government General Hospital, Madras.

FIG. 1

FIG. 2

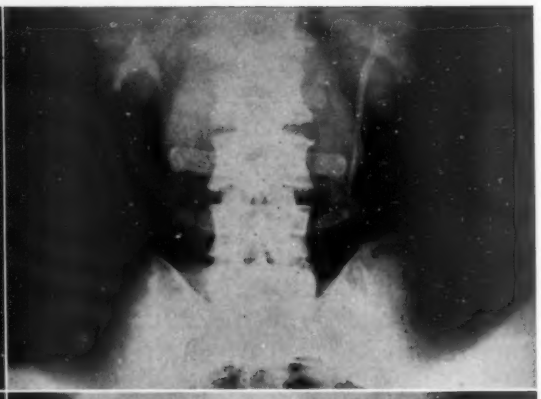

FIG. 3

FIG. 4

FIG. 5

FIG. 6

FIG. 1. Five minutes after intravenous injection of uroselectan.
FIG. 2. Fifteen minutes after intravenous injection of uroselectan.
FIG. 3. Thirty minutes after intravenous injection of uroselectan.
FIG. 4. One hour after intravenous injection of uroselectan.
FIG. 5. One and a half hours after intravenous injection of uroselectan.
FIG. 6. Two hours after intravenous injection of uroselectan.

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RADIOLOGICAL EDUCATION IN ENGLAND*

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HISTORICAL

HOW widespread was the interest in the thrilling months that followed the discovery of the x-rays is well shown by the attendance register of a meeting held in London on November 5, 1897. The list of those present includes physicians, surgeons, general practitioners, physicists, manufacturers of electrical and photographic apparatus, photographers, business men, politicians, and, in fact, every Tom, Dick and Harry. This meeting was the beginning of radiological education in England, for it led to the formation of the first society for the study of x-rays, the Roentgen Society. Formed in 1897, it still flourishes, incorporated with the British Institute of Radiology. Moreover, the first x-ray journal, *The Archives of Skiagraphy*, founded only four months after the discovery, was taken as its official organ and there is an unbroken sequence of publication to the present day.

Among those who took up x-ray work there were only a few medical men, for the new photography was regarded as a technique with a limited field of usefulness in the detection of fractures and foreign bodies. Of the laymen some photographers turned their ability to produce pretty pictures to practical account—one such was the most successful private roentgenographer in London till war days or even later, much to the distress of his medical competitors. Men who knew some elementary electricity and could deal with makeshift apparatus were in their element. The ability to produce an x-ray picture was the one and only necessary qualification to the practice of radiology.

For many years the radiologist's chief concern was the production of pictures and he had little time for the study of that vast subject that we now know as radiology. Our medical brethren were dreadfully slow to realize the fallacies and difficulties of roentgen interpretation and the early workers were sorely put to it to justify their existence as radiologists. So far as his colleagues were concerned, the science of medical radiology was hardly recognized until the Great War made the importance of the subject self-evident. The War put radiology on the map, for the tragedies due to utter ignorance of the subject soon became common knowledge, and made it obvious that the roentgenogram was not an open book that anyone could read; it was printed in a language requiring specialized study. At that time there were few who had acquired this specialized knowledge, and one remembers numbers of instances of men who had literally no experience or knowledge, some of them not even medically qualified, who came beseeching for a day or so of instruction because they had been posted in charge of the x-ray work of war hospitals.

THE CAMBRIDGE DIPLOMA IN RADIOLOGY

In 1916 Thurstan Holland, in a Presidential Address to the Roentgen Society, pointed out that the War had revealed in tragedy the criminal folly of placing untrained men in charge of x-ray departments. The moment was opportune for the first serious attempt to provide a systematic course of training for those who wished to study radiology. Neither of the existing Societies, even if they had had sufficient standing in the profession, could sponsor such work, and it was clear that if a qualifying examination was to take rank it must be put under the aegis of one of the universities. I well remember the first meeting—

* Read at the Fifth International Congress of Radiology, Chicago, Ill., Sept. 13-17, 1937.

sociable, enthusiastic, quite informal, and of the type which says "here is something that must be done; let's do it at once." It fell to my lot to sound the University of Cambridge, for it was agreed that the prestige of its Medical School, if it could be persuaded to undertake the task, would do much to establish the standard of a diploma. Within two days the foundations had been laid at Cambridge. The wheels of our old universities move very slowly, however, and it was not until 1919 that the course was finally arranged. The first examination was held in 1920. The syllabus was fairly strong on the diagnostic side, but roentgen and radium therapy were still very much in their childhood's stage of empiricism. Electrology had to be included in the course for two cogent reasons, which can hardly be regarded as such today: (1) roentgenology and electrology were both dependent on electricity, and (2) there was not a living to be made from radiology alone. Hence, the new qualification became the Diploma in Medical Radiology and Electrology.

Cambridge is a small country town, dominated by a large University, and its one hospital was obviously too small to provide either facilities or teaching material for more than two or three students. Clearly the case was comparable to the ordinary medical curriculum of the University, in which the pre-clinical teaching is done in Cambridge and the clinical work chiefly in the wards of the London hospitals. The importance of physics in the development of radiotherapy was beginning to be realized, and it was therefore arranged that this subject, together with elementary radiology and electrology, should be done either in Cambridge or in London. The clinical work would follow later in the x-ray departments of the London hospitals and would be combined with systematic lectures by specialists in their own subjects. These were to be given under the auspices of a new medical society, which shortly afterwards became the British Institute of Radiology, whose chief object was to advance education in medical radiology. It had only a small membership and financial difficulties soon arose. Hence, with many misgivings, it incorporated the original Roentgen Society, with its mixed membership, and therefore ceased to be purely medical. Nevertheless, the liaison with Cambridge in teaching for the diploma continued and has always worked smoothly and satisfactorily, for the non-medical members left this side of the Institute's activities entirely to the medical members.

At first the diploma was granted to a certain number of the senior radiologists on presentation of a thesis. Some 32 diplomas were granted in this way, some of them going to distinguished American candidates. The syllabus for the examination was intended to be an outline of radiology; no more was possible in six months, a period later extended to one academic year. It ensured, however, that successful candidates must have a reasonably sound groundwork on which to build the experience that would come later. Various minor changes have been introduced in the curriculum to meet the ever widening scope of radiological practice, but the original syllabus was sound and no radical changes have been necessary. When the course was extended to one academic year a thesis was demanded in addition to the examination, but this was abandoned, as, although it stimulated the good man to original work and research, it was of no value to the average candidate and did not ensure that he gained the all-round knowledge and experience as assistant in a department during the final three months that were allotted for this exercise. The routine course, therefore, was extended to cover the full academic year.

At this time also the cooperation of pathologists was enlisted, and this side of the subject was brought up to as high a standard as could be aimed at in the limited time at the student's disposal. Another modification which experience showed to be very necessary was the insistence on reasonable post-graduate clinical experi-

ence before taking up the specialized study of radiology. The examination, divided into two parts, was searching: two written papers in physics and two in radiology, together with a practical examination in a physics laboratory, a *viva voce* of about twenty minutes in radiology and one of a shorter period in electrology. It was regarded by the examiners as a pass, not as an honors, examination, and the standard required, if it could be expressed in figures, was at least 75 per cent. Some 400 diplomas have been granted by examination; roughly speaking, three-quarters of these have been taken by graduates of British universities and a quarter by men from our colonies and dependencies, with a sprinkling of other nationals, two from the United States of America, four Japanese, five Dutch, six Greek, seven Rumanian, two Egyptian, three German and eight Chinese.

OTHER DIPLOMAS

It had been hoped by the originators of the scheme that there would be one diploma in radiology and one only, but the insistence of Cambridge on students being trained for the examination in classes for which the University was responsible led to the starting of two other diplomas, the one in Liverpool under Thurstan Holland, and the other in Edinburgh. For these two new diplomas the syllabus was very similar to that of Cambridge, but the number of candidates was restricted to, say, six for each class, owing to the limited facilities for clinical work, as compared with those of the numerous teaching hospitals in London, which are all schools of London University. In 1926 a Professorship of Radiology was attached to London University, and, as was natural, a move was made to establish yet another diploma. Why should its schools teach for a diploma granted by another University; why not have a London University diploma? Accordingly, the Academic Diploma in Radiology, which did not include any electrology, came into existence. At the same time the Conjoint Board of the Royal College of Surgeons and the Royal College of Physicians also decided to grant a diploma for men in the Services, colonial and overseas doctors, who could not attend the recognized courses but who might have learned their radiology elsewhere. This diploma has not, however, attracted many candidates.

It was expected that this plethora of diplomas would very seriously affect the Cambridge entry, but in point of fact the average entry of between twenty-five and thirty has persisted. It was also prophesied that it would lead to a lowering of standards in order to attract students, but this prophecy has not been fulfilled.

Very recently two diplomas have been instituted in Australia, one in Sydney, where as yet no examinations have been held, and the other in Melbourne, where separate diplomas in diagnostics and therapy, including electrotherapy, have been scheduled. Only one examination has been held so far, and the candidates all entered for the diagnostic diploma. These Australian diplomas are based on approximately the same syllabus as those of the English ones, and the Melbourne papers indicate a high standard. The insistence on two years of clinical medicine after qualification before taking up radiology and on twelve months' experience as assistant in a radiological department, are features that might well be copied.

It will be seen, therefore, that in addition to the original Cambridge diploma, which still draws about two-thirds of the candidates, we have three University diplomas in the British Isles and two in Australia. The standards of all have been raised as the years have passed and as experience has been gained. There is no doubt that as a pass examination any of these diplomas is adequate to ensure that the successful candidate will have the basic knowledge of the subject.

THE EFFECTS OF DIPLOMAS

The effects of the establishment of the Cambridge diploma were definite: (1) the

standard of work all over the country was at once raised; (2) the diploma was recognized by all appointing bodies, and an unqualified candidate stood no chance of obtaining a radiological appointment; (3) the standard of applicant for the courses gradually rose, and today the candidates are, on the whole, much more highly qualified in medicine and surgery than was the case ten years ago—there is a good sprinkling of men with the highest medical and surgical qualifications; (4) the door was firmly closed against the type of man who, without any knowledge of the subject, purchased expensive apparatus and set up as a radiologist.

Unfortunately, in spite of the undoubted success and prestige of the diploma, the University of Cambridge has decided that, having performed the service of starting the course and setting radiology on its feet, it has fulfilled its part. It has therefore given notice to terminate its diploma in 1941. What will be the outcome is not yet clear. Personally, I believe that the radiologists now hold a strong enough position to undertake the sole responsibility for granting a qualifying diploma. If such a diploma should be established, the University qualifications might be allowed to lapse, and we should then have a one-portal system of entry that all will agree is the most satisfactory.

A FELLOWSHIP IN RADIOLOGY

There can be no gainsaying the value of our diplomas as a qualifying standard, but a higher qualification has long been called for, one that will compare with the highest degrees in other branches of medicine. With this in view, the British Association of Radiologists was formed two years ago and has established a Fellowship. A number of these fellowships have been granted to senior radiologists, as is usual in such matters, but hereafter the fellowship will be attained only by examination, which will be of a high honors standard. A strong feature of this examination is the insistence on a very sound knowledge of general medicine, surgery and pathology, and to this end specialists in these branches will sit as examiners with the radiologists. Candidates must attain an honors standard in either diagnostics or therapeutics and also present a thesis in their honors subject. This fellowship examination is only open to candidates who have attained one of our recognized diplomas or that of the American Board of Radiology.

RADIOLOGY IN THE MEDICAL CURRICULUM

There have been many moves to include radiology in the general medical curriculum, and this has been done in practically all our universities. Routine instruction is included in the anatomical course, but I do not know of any such instruction in the physiological side of the subject. Provision is also made for instruction in the final years of the curriculum and in most universities a satisfactory, if brief, course is routine. In others, the course is perfunctory, both as to the time allotted and as to the nature of the teaching. The excuse is invariably that the time of the students is so limited that no further crowding of the course is possible.

THE EDUCATION OF THE TECHNICIAN

This brief summary would be incomplete without a passing reference to the exceedingly valuable work done by the Society of Radiographers, which came into existence in 1921. This body, which includes a very large proportion of the technical assistants, is governed by a board on which radiologists are well represented. It is affiliated to and housed at the British Institute of Radiology. Everything possible is done to ensure that members confine themselves to their rightful sphere, i.e., to the technical side of the subject. Members sign an agreement not to report on roentgenographic examinations. The Society has more than a thousand members and is very active in protecting their interests. Its examinations, conducted

partly by roentgenographers and partly by medical radiologists, attain a high standard; they are held simultaneously at five centers in the British Isles and also in South Africa, and all the papers are marked by the board of examiners in London. As the Society has grown in strength, the period and conditions of training for the examinations that lead to membership of the Society of Radiographers have been stiffened. The latest syllabus stipulates for two years' training, which must be in one of the approved hospital schools. Success in this examination is now the only door through which the technician may become a member of the Society. The most recent move is the institution of a fellowship, which is open to workers of ten years' standing on presentation of a thesis and to members of three years' standing by examination. A journal is now established on a modest scale, and, in brief, the Society not only flourishes, but works in entire harmony with the radiologists.

THE FUTURE

As to the future: Various changes in the course of training might be mentioned, but they are relative details. The greatest need in radiology is for men of the highest standing in medicine. In no branch is it more essential that our graduates should be able to stand all square with their colleagues in other specialized branches. If they cannot do so, their departments are of relatively little value and the service might as well be supplied by intelligent technicians. It is only the ability to be a real consultant and to apply radiology to the problems of medicine, whether in diagnostics or therapeutics, that justifies the specialist practice of radiology.

Another great need is experience in clinical medicine—the more the better—before taking up radiology; the man who cannot see through his roentgen film or screen image to the clinical picture of a patient lying on his bed is as much use as a pathologist who does not see beyond the sections under his microscope or a dermatologist who only thinks of ointments in the treatment of skin conditions. Radiology, to be of full value, must be one facet of clinical medicine, and must never be far separated from it; it may be carried out in a laboratory, but it is really a clinical and not a laboratory method. A radiologist without clinical experience is an anachronism.

The standards required of a radiologist are high, yet the rewards are not great. In private practice the cost of apparatus and of keeping up to date, together with working costs, soon reduce relatively high fees to a modest income, even for the successful practitioner, while the average man often has difficulty in balancing his desire to keep up to date with the need for cash with which to educate his family. Considering the difficulties, the standard of work in private practice is good, but it is not, and cannot be, as high as that to be found in the hospitals, where our colleagues see to it that we are not hindered by lack of apparatus in rendering the most effective radiological service possible.

The outlook for the private practitioner in radiology is none too bright. In England we depend very largely on the voluntary hospital, maintained by the gifts of the charitable. The radiologist gives his services to the hospital and expects his colleagues, who work on the same basis, to send their private work to him at his consulting rooms. During the slump, many sought the service of the hospitals who would not otherwise have done so; yet, with the return of prosperity, these patients do not go back to the private radiologist. They and their friends found the hospital service efficient; why should they pay for services which, at the hospital, they can obtain free, or for a nominal fee? Of this modest fee, the radiologist often receives no share. Until recent years the voluntary hospitals were available only for those who accepted the charity of the institution; but things are changing, and provision is now being made for paying patients and the radiologist shares in the reduced

fees that are charged. Two scales of fees for such patients, graded according to income, have been drawn up by the British Institute of Radiology, and these have been of considerable value. When the work is done in a hospital department the radiologist takes a fixed proportion of the fee. There is, however, much abuse, and many patients who could well afford to consult the radiologist in his private capacity are passed through the hospital services—our colleagues, acting in the interest of their patients, obtain their radiological information in the cheapest market and do not consider the problem of the radiologist, who is attempting against odds to provide the best possible private service. The problem is becoming acute, for, even with the return of trade, the number of patients willing and able to pay private fees is not increasing. Roughly speaking, private work, on which the radiologist depends for his living, is at a standstill, whereas the work in hospitals tends to double itself every five or six years. This means that there is not only more unpaid work for him to do but that there must be more and more assistants in the hospitals. The salaries these assistants receive are low—learners' salaries, as a rule—yet there are relatively few openings for these men when they have gained their experience. Good men will not be attracted to radiology if at the end of their probation there are not satisfactory openings for making a reasonable livelihood. The problem is parallel to that of the pathologists, and the only solution lies in adequately salaried posts, which, under the voluntary hospital system, is almost impossible. The exploitation of the radiologist in the interests of economy in the voluntary hospitals is most unsatisfactory, for these hospitals cater more and more for patients who could well afford at least a modified fee. But changes are rapidly taking place. State and municipal hospitals are now challenging the efficiency of the voluntary system, and our voluntary hospitals must, sooner or later, become state aided, and the medical appointments will be salaried posts. So far as the radiologist is concerned, the sooner this takes place the better, provided that the salaries are adequate. There is room for only a very limited number of radiologists who depend on private practice for their living and there is urgent need for ten times this number to cope with the demands of the hospital service. Permanent and adequately paid staffs are an essential condition for efficiency in hospital services.

SUMMARY

In the British Isles we believe that we have a satisfactory standard for our diplomas. They ensure the basic knowledge on which to build experience. We now have also a fellowship for those who aim at higher standards. The most pressing problem of the future does not lie in the education of the radiologist but in the fact that a larger number of radiologists is needed to deal with the hospital work than can be supported by private practice. The only solution lies in the creation of adequately paid hospital posts.

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PLEUROPULMONITIS FOLLOWING IRRADIATION*

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WHETHER intensive roentgen therapy produces concomitant deleterious effects on the lung is still a moot question. The increased use of protracted fractional irradiation and more intensive dosage from high voltage roentgen apparatus makes the question of damage to lung tissue during the course of irradiation of a cancerous breast very important. Clinical experience has indicated a definite resistance of lung tissue to irradiation.

In 1922 Groover, Christie and Merritt[2] again called attention to the occurrence of pneumonitis following roentgen therapy for breast carcinoma and in 1934 McIntosh[5] also noted this condition in reporting the occurrence of pleuropulmonitis following protracted roentgen therapy through the thorax in the treatment of 8 cases of cancer of the breast.

In the course of our observation of hundreds of cases over a long period of time treated in the Radiation Therapy Department at Bellevue Hospital and in the New York City Cancer Institute, we were impressed with the absence of such occurrences and in the Year Book of Radiology for 1935 stated that, in our opinion, when pleuropulmonitis did occur, as in the cases mentioned by McIntosh, it was due probably to some difference in technique. McIntosh irradiates directly through the chest; our method is to apply the rays tangentially to the chest wall.

In 1936 Adair,[1] alluding to this comment of ours, stated that in his experience he had seen such occurrences in cases receiving very heavy doses (over 1,200 r per portal). In younger people, Adair says, this phenomenon is more apt to occur. He further states that, despite the heavy irradiation delivered with the large 4 gram radium pack, pneumonitis did not occur. While metastatic involvement of lung and pleura has not infrequently been encountered in our autopsy study of patients dead of breast carcinoma, in no instances have we noted pleuropulmonitis due to irradiation.

Because of these statements by various authors regarding the development of pleuropulmonitis following irradiation, we undertook a special study of the effects of intensive irradiation in 7 selected cases treated on the Radiation Therapy Service of Bellevue Hospital over a long period of time. Roentgenograms of these cases were studied before, during and after treatment. We shall not discuss at length our technique, but we are of the opinion that direct irradiation through the lung in the treatment of cancer of the breast is not advisable. That is why our method of roentgen therapy is limited to the tangential technique.

All the cases were of women with definite malignant breast lesions. Of the 7 cases, 3 were postoperatively treated; 1 was given preoperative and postoperative irradiation; 3 cases were treated solely by irradiation. High voltage roentgen therapy was employed exclusively, but in 2 cases additional irradiation was administered with either the large radium pack or interstitial radium needle implantation.

The patients were of various ages, the youngest thirty-nine and the oldest seventy-one. All but one were married or had previously nursed children. The period of observation extended over a period of three months to two and one-half years. Interpretation of the roentgenograms was made for us by Dr. Lewis J. Friedman, Director of the Roentgen Department of Bellevue Hospital. In all the 7 cases treated and reported herewith, the roent-

* Read before the New York Roentgen Ray Society, February 15, 1937.

gen-ray factors used were identical: 200 kv., 4–6 ma., 40 cm. target distance, 0.5 mm. copper plus 1 mm. aluminum filtration, and the treatment was always given in divided doses unless otherwise stated, each dose being 150 r, measured in air. The plan of treatment and the portals used were as follows: The anterior chest and axilla were treated tangentially, with two crossfiring 20×20 cm. fields; the roentgen rays in the upper field centering at the midclavicular region; the lower, at the level of the fifth rib, thus producing a maximum of radiation over the anterior midchest and axilla. The posterior treatments over the scapula were given at a tangent with rays centering at the posterior axilla. Except in rapidly given preoperative roentgen irradiation, one area was treated each day, the areas being alternated so that each received a treatment every third day.

The radium pack used is composed of 5 grams of radium element with a filtration of 0.5 mm. platinum plus 5 mm. lead. This is applied at right angles to a 7×10 cm. area at a distance of 6 cm.

CASE REPORTS

Case 1. E. D., aged thirty-nine, weight 140 lb., single, white woman. The patient was admitted on February 14, 1934, when she showed massive involvement of the right breast with a carcinoma of the inflammatory type which, in the opinion of the surgeons, was inoperable. A preliminary roentgen examination of the chest showed no lung involvement. Between February 14 and April 2, 1934, roentgen treatment was given to three areas, upper anterior right chest, lower anterior right chest and right scapula areas, each anterior area receiving 2,000 r and the posterior area, 1,600 r, making a total of 5,600 r directed into the chest. In May, the patient was treated with the radium pack directed over three areas, inner right breast, outer right breast and axilla. The radiation was directed at right angles to the lung. The areas were treated on alternate days, 5,000 mg-hr. each to one area. From May 28, 1934, to June 27, 1934, the inner breast area received 45,000 mg-hr.; outer breast 35,000 mg-hr., and the axilla, 40,000 mg-hr., a total of 120,000 mg-hr.

A roentgenogram of the chest taken March 31, 1934, after the preliminary treatment was completed, showed no lung changes. The skin at this time developed a second degree burn but at no time did the patient have any symptom or sign indicative of lung pathology. Roentgenogram of the chest on July 12, 1934, again showed the lungs to be clear. Similar roentgenograms were taken in August and October, 1934, January and June, 1935, and February, 1936. In none of these was there any evidence of change in the lung parenchyma or pleura. The patient has been examined at monthly intervals and to date there is no pleuropulmonitis.

Comment. In this case, even though massive dosages of both roentgen rays and radium were administered, no pleuropulmonitis has ever manifested itself.

Case 11. H. S., female, aged seventy-one. In May, 1934, the patient was admitted with an inoperable carcinoma of the right breast with large fixed axillary nodes. She was very thin and weighed only 100 lb. It was decided to treat the lesion only with intensive roentgen therapy.

The roentgenogram taken May 3 showed no lung involvement. From May 7 to June 14, 1934, she received treatment to the three chest areas, upper right chest, lower right chest and posterior right scapula. Each area received a total of 2,000 r, making a total of 6,000 r. A chest roentgen examination made July 25, 1934, showed no lung changes.

On July 25, 1934, the axillary nodes had disappeared and the breast had shrunk to one-third of its original size. As this condition did not change, from September 12 to October 24, 1934, a second series of roentgen treatment was applied as before with a dosage of 1,390 r to the right lower chest, 1,540 r to the right upper chest and 1,540 r to the scapula area, making a total of 4,470 r given. The chest plate on October 29, 1934, five days after treatment was completed, again showed no lung alteration. The patient would not come to the clinic during the winter months but a roentgenogram taken in June, 1935, when she again appeared at the clinic showed no pathology in the lung tissue.

Comment. To date the local condition has remained stationary but even though pel-

vic metastases have appeared, no pleuropulmonitis has been detected.

Case III. H. R., a married woman, aged forty-four, and weighing 112 lb., was admitted to our service on December 5, 1935. She had carcinoma of the right breast with a mass 12× 6 cm. in the lower half. Preliminary roentgen examination of the chest showed no involvement of either lung. A preoperative series of nine intensive roentgen treatments was given directly over the tumor. Two areas, upper and lower right breast, each received 150 r daily, and a total of 1,200 r was given in four days to the combined areas. A radical mastectomy was carried out four days after completion of the roentgen treatment. On December 27, 1935, postoperative roentgen therapy was begun in the routine manner to the upper right chest, lower right chest and right scapula areas. From December 27, 1935, to February 10, 1936, each anterior chest area received 1,500 r and the posterior 2,100 r, a total of 5,100 r.

The chest examination of February 21, 1936, eleven days after treatment was completed, showed no lung changes, although the skin developed a second degree burn. To date, there have been no demonstrable recurrences or metastases or any pneumonitis.

Comment. Although this patient, who was physically poorly developed, had received intensive irradiation sufficient to cause a second degree burn of the skin, yet no demonstrable pleuropulmonitis developed.

Case IV. L. H., female, aged sixty-six, weight 142 lb. In August, 1933, this patient was referred to our service following two previous removals in a year of a local breast tumor, the first being reported to have a benign pathology, the second, on pathological examination, as duct cell carcinoma with metastatic lymph node involvement. No further surgery was attempted. There was no palpable breast or lymph node pathology at the time of treatment.

She was given in turn, roentgen irradiation, interstitial radium and radium pack treatment. From August 3 to 15, 1933, two areas were treated on alternate days, right breast and axilla with a 10×15 cm. field and right supraclavicular area with a 10×15 cm. field. Each area received a total of 750 r, a total of 1,500 r of roentgen therapy. A chest roentgenogram taken August 19, 1933, showed no lung pathology. On August 24, 1933, ten 6 mm., 3 mg., radium element needles were placed about the periphery of the right breast, a total dose of 5,184 mg-hr. being given. From November 6 to December 6, 1933, a second series of roentgen treatments was given 1,500 r to each of the two areas, with a total of 3,000 r. The patient remained well. Between June 27 and July 16, 1934, a prophylactic series of roentgen treatments was given to two areas, upper right chest and lower right chest, in the routine manner; 20×20 cm. fields exposed tangentially and overlapping in the anterior midchest region. Alternate areas were treated each day, each area receiving a total of 1,200 r, a total of 2,400 r being given. The patient remained well until June 12, 1935, when a mass 4 cm. in diameter recurred in the right breast, together with small axillary nodes; the chest roentgenogram taken at this time showed no lung changes.

From June 12 to July 25, 1935, intensive roentgen therapy was given again to three areas in the routine manner already described—upper right anterior chest, lower right anterior chest and right scapula areas, each receiving 1,500 r, a total of 4,500 r being given over the lung. Though the mass almost disappeared, additional therapy was given in the form of the radium pack. Two areas were exposed, lateral right breast and right axilla. Between August 28 and September 23, 1935, each received 45,000 mg-hr., making a total of 90,000 mg-hr. delivered to the chest. Three weeks later the mass had disappeared and the skin was deeply bronzed. A roentgenogram of the chest taken December 20, 1935, showed no changes in the lungs or pleura. The roentgen examination was repeated on January 30, 1936, more than two and a half years after the first treatment, and again no lung changes were found. The patient has remained without apparent recurrence to the present date.

Comment. In spite of repeated intensive roentgen therapy and large doses of radium applied in this case, there occurred at no time any evidence of pleuropulmonitis.

Case V. T. W., a married woman, aged fifty-two, was admitted on March 4, 1935, following a radical mastectomy for carcinoma of the left breast. Two and one-half months previously,

the patient already had left axillary recurrence. On admission, she weighed 107 lb.

The roentgenogram of the chest, taken March 6, 1935, showed no lung changes. From March 4 to April 30, 1935, she received roentgen therapy to the customary three areas, upper and lower left chest and posterior left scapula on alternate days. Each area received 1,200 r, a total of 3,600 r delivered through lung tissue.

The roentgenogram taken June 19, 1935, showed no lung changes. Because of residual nodes, radium pack therapy was given to the left axilla and to the left supraclavicular areas from August 7 to 15, 1935, alternate areas being treated on alternate days. Each area received 30,000 mg-hr.

A roentgenogram taken September 12, 1935, showed no lung changes. The recurrences disappeared under this therapy. On February 6, 1936, the roentgen examination of the chest again revealed no lung pathology.

She remained free from recurrences but because of the danger of residual cancer cells, the routine high voltage roentgen therapy was repeated. From March 4 to April 15, 1936, the left upper chest received 1,200 r; the left lower chest 1,200 r, and the posterior scapula 1,650 r, a total of 4,050 r. This produced desquamation of the chest wall, yet a roentgenogram taken May 21, 1936, showed normal lung tissue with no signs of pleuropulmonitis.

Comment. As in the other cases where intensive irradiation was administered no pleuropulmonitis was manifested.

CASE VI. A. O., female, aged fifty-two, weighing 127 lb., was admitted August 5, 1935. Eight months previously she had had a radical mastectomy for a lump of two years' duration in the left breast. Upon admission, there was a small node in the left supraclavicular region.

A roentgen examination of the chest taken August 15, 1935, showed extensive fibrosis of both lungs, in other words lung tissue already damaged by pre-existing disease. Between August 13 and September 26, 1935, she received roentgen treatment in the routine manner to the left upper chest, left lower chest and posterior left scapula areas, one area being treated on alternate days. Each area received 1,500 r, a total of 4,500 r to the combined areas. Desquamation of the skin of the anterior left chest and axilla followed the treatments. She developed no untoward symptoms during or following irradiation and the roentgen examination of the chest on February 7, 1936, showed no change in the lung fibrosis on either side.

Since there was a recurrence in the left axilla and several small left supraclavicular nodes, radium pack treatment was given from January 23 to February 7, 1936, to these two areas, alternate areas being treated daily. Each received 35,000 mg-hr., the total irradiation being 70,000 mg-hr. The skin over these areas had a very marked erythema. The recurrence shrunk to a fibrotic thickening below the anterior axillary fold.

The chest roentgenogram of May 20, 1936, three months after treatment, showed an unchanged fibrosis of both lungs.

Comment. In this case, a woman with a lung already showing changes due probably to a recurrent bronchitis as indicated by the past history was apparently unaffected by the heavy bombardment of intensive deep roentgen irradiation.

CASE VII. F. D., female, aged forty-eight, weight 146 lb., was admitted to the radiation service following a simple palliative right mastectomy five weeks previously. There was still present a hard fixed node in the right axilla. A roentgenogram of the chest taken before the treatment showed no lung pathology.

From June 5 to July 10, 1933, she received deep roentgen therapy to three areas, posterior right chest with a 20×20 cm. field, anterior right chest with a 20×20 cm. field and right supraclavicular area with a 9×12 cm. field. One area was treated daily, each area receiving one exposure every third day. The total radiation delivered to each area was 1,200 r, a total of 3,600 r on lung tissue.

The node in the right axilla receded to a mere fibrotic scar. From November 15 to December 3, 1933, the treatment was repeated, this time omitting the posterior chest area. The right supraclavicular and anterior right chest areas each received 1,200 r, making a total of 2,400 r. A roentgenogram of the chest taken January 10, 1934, one month after treatment, showed no pathology of lung or pleura. The metastatic axillary node had completely disappeared at this time.

In June, 1934, a small hard right supraclavicular node was palpated. Though this remained unchanged, further roentgen therapy was started on August 29. From August 29 to September 20, 1934, deep roentgen therapy was given in the routine manner to upper and lower right anterior chest, each receiving 1,200 r, a total of 2,400 r over the chest. The roentgenogram of December 21, 1934, showed no pathology of lung or pleura. The node in the supraclavicular area had disappeared. In July, because there were numerous shiny nodules on the chest wall, deep roentgen therapy was discontinued and treatment given with superficial unfiltered roentgen rays. Roentgenograms taken in October, 1935, and January, 1936, showed no latent effects of the heavy irradiation previously applied.

Comment. Repeated intensive irradiation plus superficial roentgen therapy did not produce pleuropulmonitis in this case.

To summarize the type of therapy administered to these cases, as to amount, kind, and intensity of treatment given, the facts are:

Case I, aged thirty-eight, weight 142 lb., received 1,600–2,000 r of deep roentgen therapy per portal, a total of 5,600 r and 120,000 mg-hr. with the radium pack over a period of four and a half months.

Case II, aged seventy-one, weight 100 lb., received a total of 10,470 r of deep roentgen therapy or 3,390–3,540 r per portal over a period of five months.

Case III, aged forty-four, weight 142 lb., received a total of 7,200 r, or 2,000–2,100 r per portal over a period of two months.

Case IV, aged sixty-six, weight 142 lb., received a total of 8,470 r of deep roentgen therapy or 1,500–3,435 r per area. She received 5,184 mg-hr. with interstitial radium and 90,000 mg-hr.with radium pack, 45,000 mg-hr. per area. This combined therapy was given over a period of two years.

Case V, aged fifty-two, weight 107 lb., received 7,600 r of roentgen therapy or 2,400 to 2,850 r to each area, and a radium pack treatment of 60,000 mg-hr. over a period of one year.

Case VI, aged fifty-two, weight 127 lb., received deep roentgen therapy to a total of 4,500 r, 1,500 r per portal and radium pack treatment to a total of 70,000 mg-hr. within a period of six months.

Case VII, aged forty-eight, weight 146 lb., received a total of 8,400 r with deep roentgen therapy, or 2,400–3,600 r per area over a period of fifteen months.

CONCLUSIONS

From our study of the cases herewith reported, we are of the opinion that pleuropulmonitis, as described by others, occurs in cases when cancer of the breast is treated by intensive irradiation with the rays passing through the lungs, and may well be due to the technique employed or to a concomitant infection.

Perhaps the explanation for post-irradiation fibrosis in this anatomical site is identical with that in other sites. The pelvis, abdominal cavity or any parenchymal organ may be irradiated with no alteration in the absence of pathology, but when a concomitant infection is present, then fibrosis ensues.

In the large number of cases treated by us, including the particular cases reported herein, following the use of direct intensive irradiation of the breast, no pleuropulmonitis occurred.

In the treatment of these specifically selected seven cases, reported herewith, with the modification employed, we have utilized varying factors of intensity and quality of radiation, and direction of the radiation. Admittedly with high voltage roentgen rays, the depth dose is great, but the direction of the ray is tangential and perhaps that factor obviates lung tissue pathology. With the 5 gram radium bomb, the depth dose is smaller, but because of the size of the field, the beam is always directed into the lung. The intensities vary with roentgen rays and radium.

Since we had no clinical evidences of pleuropulmonitis in any of the several hundred cases treated by us for carcinoma

of the breast nor in the seven cases especially observed for this condition, we conclude that intensive irradiation when directed tangentially to the chest wall for carcinoma of the breast does not damage normal lung tissue.

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RADIATION TREATMENT OF HERPES SIMPLEX*

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HERPES simplex, commonly known as cold sore or fever blister when appearing on the face, causes the average person little or no concern, but there are certain very suceptible individuals in whom the condition produces most annoying signs and symptoms. These individuals have frequent recurrences of herpetic lesions which persist for several weeks and produce unsightly sores with disagreeable symptoms of itching and burning in the acute stages. Any reliable treatment for these lesions will be welcomed by such persons, since it is common knowledge that the present modes of treatment are at best very ineffective.

The etiology of herpes simplex is still somewhat obscure. It is common in meningitis, pneumonia, malaria, and to a less extent in a few other febrile diseases. It is frequently associated with coryza—hence the name cold sore. It may be associated with focal infections, particularly with bad teeth; but it is perhaps most often found in the apparently healthy individual who may observe that he has a comparatively mild digestive disorder at the time the lesion appears. The causative agent in herpes simplex is now rather generally conceded to be a filtrable virus which produces a characteristic keratitis and encephalitis in rabbits. Herpes zoster is evidently caused by a different but probably related virus. An interesting analogy exists between the causative organisms of herpes simplex, poliomyelitis, rabies, small-pox, and lethargic encephalitis due to their neurotropic and epidermotropic properties. There is much evidence to show that the virus of herpes simplex may be transmitted by direct contact such as sexual intercourse (genital form), and kissing (labial form). One author produces evidence which tends to show that the condition may have some hereditary tendencies. Pathologically, herpes simplex is characterized by a fibrinous inflammation of the epidermis with coagulation necrosis in the prickle cell layer of the skin. A subepithelial blister then develops, the covering of which consists of the stretched prickle cell layer. Herpes simplex uncomplicated does not produce a scar.

The lesions of herpes simplex occur most often on the face or on the genital organs. Lesions of the face are most common, occurring on the nose, lips, cheeks, or auricles of the ear. Lesions may occur on the mucous membrane of the mouth and throat or in the cornea of the eye. They may also be found on the hands.

The first symptom of a herpetic eruption is usually a burning or tingling sensation which is followed in a few hours by an inflammatory edematous base on which small vesicles appear. The entire lesion may vary in size from less than 0.5 cm. in diameter to a lesion of 5 or 6 cm. across. The vesicles are usually the size of a pinhead and are closely grouped over the inflammatory base. They may vary in number from one to several dozen, depending on the size of the lesion. Within two to five days after appearance the vesicles tend to break and form crusts, the active inflammatory reaction most often subsiding about the time the crust forms. Between one and three weeks after onset of the lesion the crust falls off, the patient having an unsightly sore in the meantime if the lesion is of any appreciable size. These conspicuous crusted areas on the face together with the early tingling and irritation are the cause of annoyance to the patients.

One attack predisposes to a recurrence in the same spot or in an adjacent area. Those individuals with a susceptibility

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have the most unsightly lesions with the most disagreeable symptoms. Eruptions frequently occur in women at the menstrual period, often recurring at the same spot each month. Pregnant women or women who have just been delivered also appear to be susceptible.

Numerous remedies have been advocated to abort or cure herpes simplex. Among these remedies are alcohol, heat, and camphor water locally. Ultraviolet and water soluble vitamin B have also been used. Any individual who has had occasion to use these remedies for herpes is well aware of the fact that they are of very questionable value. The multiplicity of drugs used for the condition is evidence enough that none of them is satisfactory.

In the American literature scant mention is made of the use of the roentgen ray in the treatment of herpes simplex. However, Ludy in "The Cyclopedia of Medicine" states that fractional doses of roentgen rays have been of marked benefit in persistently recurring lesions. Terry in 1928, referring to corneal herpes, says that roentgen rays on the eye in doses sufficiently small to be safe do not have any germicidal effect on the virus of herpes. Stephenson, by analogy to the response of other infections, believes that roentgen irradiation might be of benefit in herpes of the cornea.

Most reports on the use of roentgen irradiation in herpes simplex are in the foreign literature, and these are none too plentiful. Lassueur in Europe started treating recurring facial herpes in 1908 with roentgen rays. He had treated 37 cases up up to 1928 and he states that undeniably radiotherapy gives the most satisfactory results of any form of treatment in this condition. He was able to cause a disappearance of the herpes in at least 50 per cent of his cases. He used doses of $4\frac{3}{4}$ H with 1 mm. aluminium filter repeated three times at monthly intervals, the $4\frac{3}{4}$ H being calculated without the filter, so that the actual doses were much less than this. (Note: 1 H = 100 r.) Milian says that doses of 4 H or even of 6 H are necessary to get results, and that one cannot hope to obtain a cure of all recurring herpes with a single treatment, usually four or five applications of 4 H at a month's interval being necessary, the recurrence diminishing in importance and in intensity after each of these, finally disappearing. He states that "undeniably it is incontestible that radiotherapy in situ and not over the nerve roots constitutes the most active treatment of this disagreeable affliction." Roederer reports a very good result in the treatment of recurring herpes. Pautrier also believes roentgen irradiation may be of benefit. In spite of the few reports in the literature, more than one radiologist must have observed the beneficial results from roentgen treatment of herpes simplex.

Fifteen patients have been treated for herpes simplex in the Department of Radiology of the Pennsylvania Hospital. Ten of these patients were treated during the last eighteen months. All of the patients treated had herpes labialis. Several of them had more than one lesion at various times, 21 lesions having been treated altogether. In one patient the herpetic lesions appeared each month with menstruation, but in most of them no obvious cause for the eruptions could be found.

The technique formerly used consisted of an area over the cervical nerve roots as well as one over the local lesion. The rationale of treating the cervical nerve roots is anatomically illogical, however, since the motor and sensory nerve supply of the lips is derived from cranial nerves. Only the local lesion has been treated during the past eighteen months, with results which are equally as satisfactory. The treatment factors used during this time have been 130 kv., 5 ma., tube target distance 30 cm., without filtration. Over half the cases have received 375 r in a single dose with these factors. This was sufficient dosage in all our cases to produce definite improvement. In several cases as little as 125 r was used, but the results tend to show that most often this dose was too small, although several striking results were obtained with

such a technique. Unquestionably, however, the larger dose is consistently the better. A liberal amount of normal skin was included on all sides of the area treated. One millimeter of aluminium filter was used in 4 cases with very good results in spite of the fact that only 120 to 137 r was given in these instances.

The earlier the lesion was treated, the better the result obtained. Even in lesions forty-eight hours old the treatments tended to hasten drying of vesicles and to shorten the course of the affliction. In early cases it was not unusual for the tingling sensation to disappear within three hours and for the inflammatory reaction to be gone within six to eight hours. In one case (a physician) the tingling disappeared within one hour, and the marked inflammatory reaction was gone within five hours. This individual was subject to severe fever blisters recurring at frequent intervals.

All of our patients seemed to be definitely benefited by roentgen therapy. In 2 or 3 cases the results were not so striking, although the course of the disease was undoubtedly shorter following the treatment.

Case histories on a few patients are presented below, those with good results as well as those with mediocre results being included. Most of these patients are staff members and other personnel of the hospital; hence an unusual opportunity has been afforded for careful observation after treatment.

REPORT OF CASES

Case I. D. G., female, aged twenty-three, married. Has had 4–5 fever blisters each year for several years. These occur mostly on the left lower lip. Patient states that all other fever blisters which she has had have lasted about two weeks and have caused unsightly crusted lesions. The present lesion appeared twenty-four hours ago on the left lower lip at the corner of the mouth. It measured 1.25 cm. in diameter and was composed of a dozen or more small vesicles on a markedly inflammatory base. It was causing considerable annoyance from itching and tingling. A single dose of 375 r was given. The tingling sensation disappeared within a few hours, the vesicles were drying up by the next morning, and the redness was gone in twenty-four hours. One week after treatment a very small flat crusted area 2 mm. in diameter was all that remained of the lesion. The patient states very positively that this treatment was of great benefit.

Case II. W. C. H., male, aged thirty. Fever blister 0.5 cm. in diameter on the right lower lip. It was composed of 2 or 3 relatively large vesicles on an inflammatory base. Considerable tingling. Given 300 r within two hours after awaking in the morning and discovering the lesion. Inflammatory reaction gone six hours later and tingling gone within approximately the same time. Forty-eight hours after treatment the vesicles had dried up, and the lesion was entirely gone within five days. This patient is subject to frequent fever blisters which always last two weeks.

Case III. H. P. R., male, aged twenty-six. Patient has frequent large crusting fever blisters which remain on the lip for about two weeks. These usually recur on the midline of the upper lip where the present lesion was found. It was 3–4 mm. in diameter, showing only slight inflammatory reaction and consisting of 1 or 2 vesicles. Very slight itching and burning. Given 375 r. Seventy-two hours later the vesicles had dried up. Patient believes that healing was hastened several days, judging by his previous experience with these lesions.

Case IV. O. K., male, aged thirty-five. Early herpes on the midline of the lower lip given 375 r. Tingling stopped within one hour and the herpes was definitely aborted. Patient is afflicted with frequent rather severe lesions. Two months later he developed an oval lesion 1 cm. in diameter on the left upper lip. It was inflamed and showed early vesicle formation associated with itching. This lesion was treated six hours after its appearance. Twenty-four hours after treatment the tingling had stopped and the vesicles were drying up. The inflammation was almost gone in twenty-four hours. Five to six days after treatment the lesion entirely disappeared.

Case V. N. S., male, aged thirty. Head cold ten days. Has had herpes simplex twenty-four hours. Lesion 1 cm. in diameter on left lower lip at corner of mouth. Tingling and inflammation. Following treatment with 325 r the

vesicles started crusting and drying up within twenty-four hours. The lesion was entirely gone within one week, and the patient felt that the treatment had been of definite value. He usually had 4–5 fever blisters per year and these last about ten days. They are often of only moderate severity, however.

Case vi. V. C., female. Post delivery developed edematous inflamed upper lip with beginning vesicle formation on the entire upper lip. Given 375 r. Prompt regression of the lesion followed, which could hardly have been a mere coincidence.

Case vii. H. K., female, aged thirty. Patient has been having very severe fever blisters for several years, occurring frequently with the menstrual periods. The lesions have always formed big crusting sores which make unsightly lesions lasting two weeks or longer. Dose of 375 r given to a markedly inflamed lesion with many vesicles extending from the right corner of the mouth to the ala nasi. Three days later not the slightest inflammation remained, and the vesicles had completely dried up, hardly being noticeable. Five days after the treatment practically no evidence of the eruption remained.

One month later a fever blister 1 cm. in diameter appeared on the upper lip at the right corner of the mouth. It was slightly inflammatory and had been present twenty-four hours, only because the patient had been unable to come in for treatment before this. A dose of 375 r was given. Forty-eight hours later there was marked improvement, the lesion having dried up in twenty-four hours.

SUMMARY AND CONCLUSIONS

1. Certain individuals are very susceptible to fever blisters, and these individuals, annoyed by irritative symptoms and unsightly sores, will welcome any reliable treatment.

2. Fever blisters, being inflammatory in nature, should respond to roentgen therapy as do other inflammatory lesions.

3. The results of roentgen therapy in the treatment of 21 lesions are very gratifying. The earlier the treatment is given, the more satisfactory the result obtained.

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SOME OBSERVATIONS ON CARCINOMA OF THE BREAST*

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THE purpose of this study has been to evaluate the results in the treatment of carcinoma of the breast in the Hospital of the University of Pennsylvania. This problem has always been a source of worry to surgeons and radiologists. If the literature is consulted, one is immediately impressed with the tremendous variation in reported results. It seems obvious that such differences cannot be attributed to the various surgical and radiological methods employed.

The late Dr. John G. Clark, former Godell Professor of Gynecology at the University of Pennsylvania, frequently reminded his associates and colleagues that, if one really wished to evaluate a given method, it was necessary to study the records of the patients who died as the result, or in spite of, the treatment they received. Such an approach has always appealed to us as an acceptable procedure for a critical analysis of the subject. We have assured ourselves of at least two truths in this presentation: first, that all of the patients had cancer of the breast, and second, those included in this analysis died with cancer.

MATERIAL

The records of 384 patients with carcinoma of the breast were available for this study. Of these patients, 230 died with carcinoma. Patients dying without known carcinoma were excluded from this series. The records analyzed were gathered over a period from 1902 to September, 1936.

CLASSIFICATION

The material has been classified according to Steinthal's[1] plan, which separates patients into three clinical groups:

Group I: Those having a tumor, apparently growing very slowly, and measuring only a few centimeters in diameter, entirely confined to the mammary gland; the skin is not yet attached and the axillary nodes are few in number and are first discerned only at operation.

Group II: Those with definitely growing tumors which, after remaining stationary for some time, begin to increase in size, the skin becomes adherent and nodes in the axilla are definitely demonstrable.

Group III: Those in whom a large part of the mammary gland has become involved, the tumor has invaded the skin and underlying structures, and frequently the supraclavicular nodes are also involved.

Group Unknown: It has been necessary to include this classification which accounts for those patients in whom the data concerning the original physical findings were either lacking or incomplete.

DEFINITION OF TERMS

Radical resection—a mastectomy including the axilla, with or without removal of the pectoral muscles. Only a few patients having this type of operation failed to have a removal of the pectoral muscles. *Simple resection*—removal of the breast only. *Preoperative irradiation*—irradiation given before surgery. *Postoperative irradiation*—irradiation given after operation. This type of irradiation has been divided into (1) immediate postoperative irradiation, (2) intermediate postoperative irradiation and (3) irradiation for recurrences or metastases. *Immediate irradiation*—irradiation applied within six weeks following operation. *Intermediate irradiation*—irradiation given during the postoperative period at any time after seven weeks had elapsed, provided recurrences or metastases had not

[1] Steinthal, C. F. Zur Dauerheilung des Brustkrebses. *Beitr. z. klin. Chir.*, 1905, *47*, 226–239.

* From the Department of Radiology, Hospital of the University of Pennsylvania, Philadelphia. Read at the Twenty-second Annual Meeting, American Radium Society, Atlantic City, N. J., June 7–8, 1937.

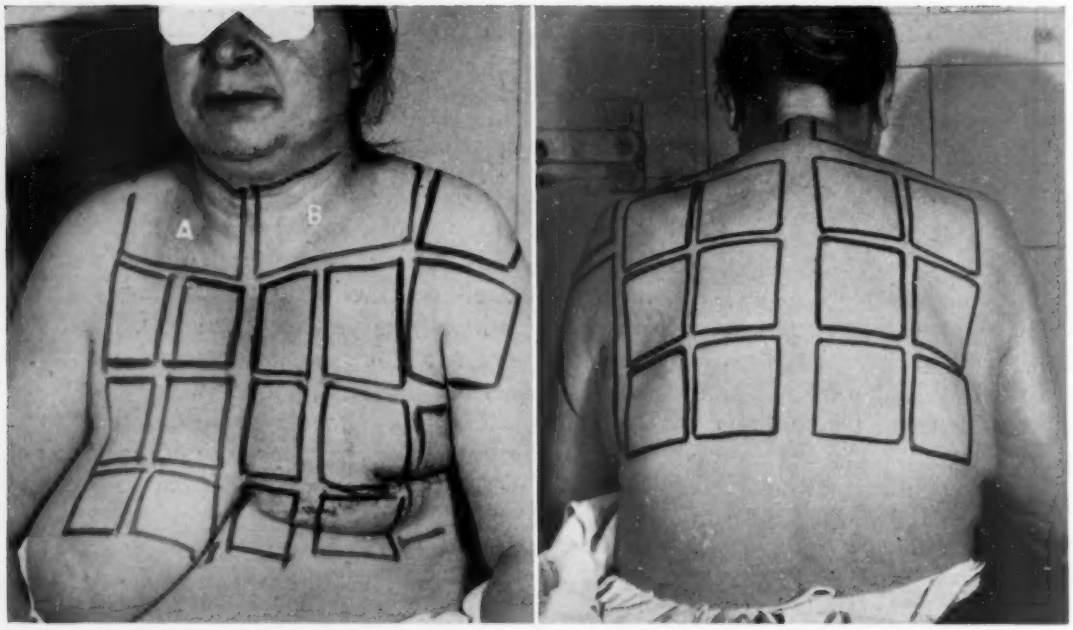

Fig. 1. Postoperative irradiation technique, 1902–1916. The supraclavicular and infraclavicular lymphatics were treated through portals *A* and *B*. The multiple beams directed through the anterior chest wall, cross-fired into the mediastinum. The axilla was treated through 3 and sometimes 4 portals. The posterior portals were also directed into the mediastinal structures. The fourth axillary portal directed into the apex of the axilla could not be included in the diagram.

developed. *Irradiation for recurrences or metastases*—irradiation given to patients who had no irradiation prior to the development of recurrence or metastasis. *Prophylactic irradiation*—irradiation directed over the healthy breast and its lymphatics in addition to the irradiation over the operative field and its lymphatic channels. *Irradiation alone*—irradiation only, without surgery.

DURATION OF LIFE

This factor was approached from three angles: (1) the period in months from the date of the patient's operation until death; (2) the period in months from the date of the first radiation treatment (in those patients not operated upon) until death; (3) the period in months from the date set by the patient as the date of onset until death.

IRRADIATION TECHNIQUE

In general, the technique used during different periods since 1902 has been relatively uniform, as treatment was given under the direction of Dr. Henry K. Pancoast. As one might expect, there has been certain individualization, which is especially true in the group treated for recurrences or metastases. While we encountered wide variations in the number of treatment cycles, no cases were included that had not received at least one complete series of treatment. Although the majority of patients were treated with roentgen rays, the radium pack and interstitial radium were freely used.

The methods for giving roentgen therapy have changed considerably since 1902. Because of this, we have separated the various techniques, as used during different periods.

1902–1916. 115 kv.; 5 ma.; 25 cm. target-skin distance; filtration, 3 mm. aluminium + 1 mm. glass (with these settings it is estimated that approximately 55 r per minute, measured in air without back-scattering, was obtained). Portals, 5×5 cm. Approximately 20 portals were used in each patient. In some patients as many as 40 portals were used. Patients were treated

daily, receiving approximately 600 r, measured in air, to each of 6 to 8 portals until the entire area had been treated once (Fig. 1). This series was repeated, on an average of six times in each patient at two to three month intervals. Crossfire irradiation was employed wherever possible, especially in such regions as the neck, axilla, the infraclavicular space and mediastinum. In some patients, these treatments were supplemented by topical application of a radium pack, containing 200 mg. of radium filtered through 5 mm. aluminium + 1 mm. rubber, at 0.5 cm. distance. In these patients, the radium pack was allowed to stay in place for twenty minutes over 4–6 portals.

1917–1921. 125 kv.; 5 ma.; 25 cm. target-skin distance; filtration, 1 mm. glass + 3 mm. aluminium + $\frac{7}{8}$ in. wood (with these settings, it is estimated that approximately 60 r per minute, measured in air, without back-scattering, was obtained). Portals, 5 × 5 cm. to 10 × 10 cm. Approximately 22 portals were used in each patient and crossfire irradiation employed wherever possible. Patients were treated daily, receiving approximately 600 r, measured in air, to each of several portals until the entire area had been treated once. This series was repeated, on an average, five times during a period of eight months. With the exception of 1.5 mm. brass + 1 mm. rubber filtration, the use of the radium pack remained unchanged.

1922–1926. 135 kv.; 5 ma.; 25 cm. target-skin distance; filtration, 1 mm. glass + 3 mm. aluminium + $\frac{7}{8}$ in. wood (with these settings, it is estimated that approximately 75 r per minute, measured in air, without back-scattering, was obtained). Portals, 10 × 10 cm. to 15 × 15 cm. Approximately 10 portals were used in each patient over the operative field and the lymphatic channels draining it. Crossfire irradiation was employed over the mediastinum, neck and axilla. Patients were treated daily, receiving approximately 600 r, measured in air, to each of 2 portals until the entire area had been treated once (Fig. 2). This series was repeated, on an average, three times during a period of six months. During this period, a 200 kv. apparatus was obtained and was used, as a rule, for treating metastases. In some patients, these treatments were supplemented by topical application of a radium pack, according to the technique described under the 1917–1921 period.

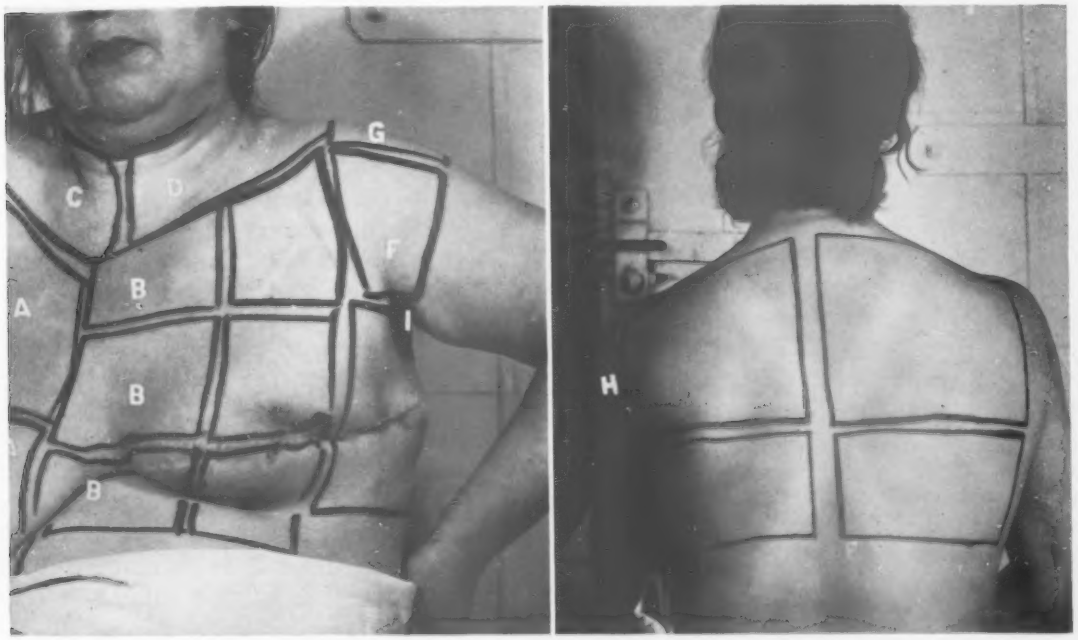

Fig. 2. Postoperative irradiation technique, 1922-1931. The anterior portals on both sides of the chest, including portals *A* and *B*, permit crossfiring into the anterior mediastinum. Portals *C* and *D* included the supra- and infraclavicular lymphatics. The axilla was treated through 4 portals, *F*, *G*, *H*, and *I*. Portal *I* directed into the apex of the axilla is not included in the diagram. The posterior portals were so arranged as to allow crossfiring into the mediastinal structures.

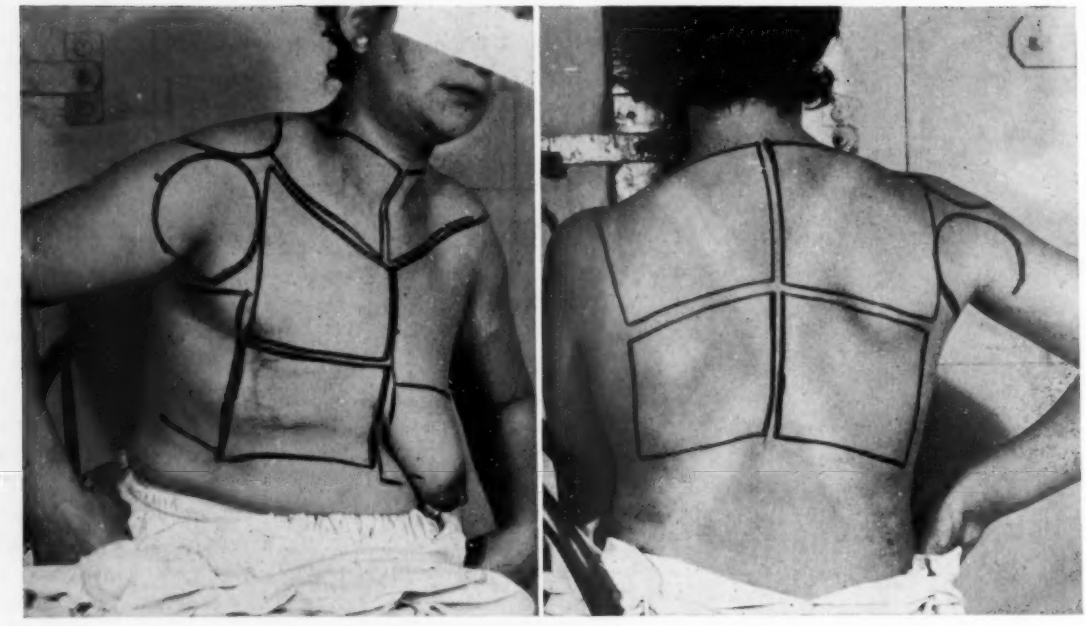

FIG. 3. Postoperative irradiation technique, 1932–1936. The anterior portals were so arranged as to allow crossfiring into the mediastinal structures. The axilla was irradiated through 4 portals. The fourth axillary portal directed into the axilla is not demonstrated in the diagram. The posterior portals also allowed the beams to converge in the mediastinum.

1927–1931. The technique employed during this period was practically the same as that used during the five years preceding. There was, however, during this period a tendency to increase the number of series given, the average number being four series over a period of about nine months. In addition, radium was filtered through 3 mm. lead+3 mm. rubber. Here again, multiple small portals were used, each area receiving approximately 1 S.E.D. During this period, interstitial radium was used considerably in the form of the emanation and the element.

1932–1936. 135 kv.; 5 ma.; 30–40 cm. target-skin distance; filtration, 5 mm. aluminium or 0.25 mm. copper+1 mm. aluminium (with these settings, approximately 40–50 r per minute, measured in air, without back-scattering, was obtained). Portals, 15×15 cm. to 20×20 cm. Approximately 10 portals were used in each patient. Patients were treated daily, receiving approximately 300 r, measured in air, to each of 2 to 4 portals. This dose was repeated until each area received approximately 600 r, which constituted one series (Fig. 3). These series were repeated every two to three months until two to three such series had been delivered. The methods for the use of radium compare with those outlined in the 1927–1931 period. High voltage irradiation was primarily used for metastases.

The preoperative technique employed during each period was very much like the postoperative technique (Fig. 4). Instead of irradiating the healthy side, numerous additional portals were directed into the breast. During the past few years, all preoperative treatment has been given with 200 kv.; 15 ma.; 0.5 mm. copper+2 mm. aluminium, at 18–50 cm. target skin distance. The fractional method has been used, each portal being treated up to skin tolerance (Fig. 5). This, as a rule, is reached at 2,000–2,400 r, measured in air. This produces a very marked reaction, which readily subsides, and is followed by surgery in about six to eight weeks.

One obtains an idea as to the relative merits of these methods by comparing the average duration of life of the patients treated by the various techniques. Table 1 presents the average duration of life in patients who were treated during these various periods. One must conclude, from the data in this table, that the efficiency of the modern methods in our hands has

not improved since the early days of radiation therapy.

ANALYSIS OF DATA

In analyzing the data, an attempt has been made to subdivide the results under the following headings, in order that the results of the various types of therapy may be evaluated.

1. Radical resection with postoperative irradiation, Table II.
2. Simple resection with postoperative irradiation, Table III.
3. Operation performed but no data as to type of operation employed, Table IV.
4. Preoperative irradiation followed by surgery and postoperative irradiation, Table V.
5. Irradiation alone, Table VI.

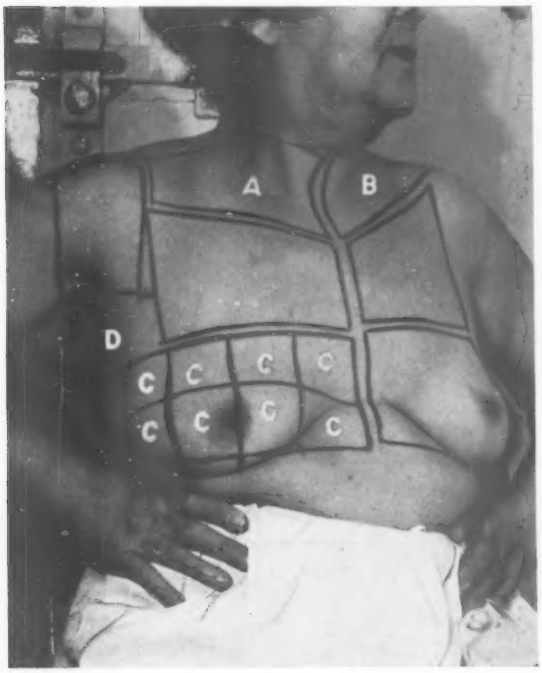

FIG. 4. Preoperative irradiation technique prior to 1934. The supraclavicular and infraclavicular lymphatics were treated through portals *A* and *B*. The large anterior thoracic portals allowed crossfiring into the mediastinum. Multiple small portals, *C*, were arranged to permit thorough crossfiring into the breast, all portals being directed at the tumor site. Portal *D* was arranged to take care of the lymphatics and the tail of the mammary gland. The axilla was treated through 3 and sometimes 4 portals. No posterior portals were treated.

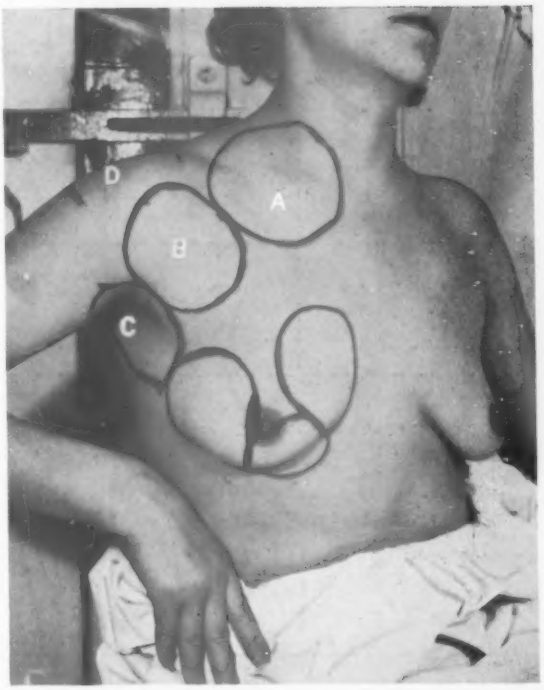

FIG. 5. Preoperative irradiation technique employed at the present time. Portal *A* includes the lymphatics in the supraclavicular and infraclavicular fossae. The axilla is treated through portals *B*, *C* and *D* which converge in the axillary apex. The breast is treated through 3 portals which are arranged to converge at the site of the lesion. This can readily be done by means of a special holder which permits one to place the breast in the desired position against the portal through which the roentgen rays are emitted. As a rule, the skin-target distance for these portals is 18 cm.

TABLE I

PATIENTS DEAD WITH CARCINOMA

Entire Series Regardless of Type of Treatment or Grouping

Patients Treated During	No. of Deaths	Average Duration of Life (months) Institution of Treatment to Death
1902–1916	13	66
1917–1921	43	52
1922–1926	79	31
1927–1931	71	35
1932–1936	24	27

TABLE II

PATIENTS DEAD WITH CARCINOMA

Radical Resection with Postoperative Irradiation

	Total Number of Cases	Average Duration of Life in Months		Average Age
		Onset of Disease to Death	Institution of Treatment to Death	
Group I	5	49	41	54
Group II	12	37	33	46
Group III	62	41	31	48
Group unknown	22	42	38	52

TABLE III

PATIENTS DEAD WITH CARCINOMA

Simple Resection with Postoperative Irradiation

	Total Number of Cases	Average Duration of Life in Months		Average Age
		Onset of Disease to Death	Institution of Treatment to Death	
Group I	4*	85	94	61
Group II	2		51	69
Group III	13†	46	40	51
	12		31	50
Group unknown	5	85	40	54

* Includes 2 patients living 142 months and 138 months.
† Includes 1 patient living 147 months.

TABLE IV

PATIENTS DEAD WITH CARCINOMA

Type of Operation Uncertain

	Total Number of Cases	Average Duration of Life in Months		Average Age
		Onset of Disease to Death	Institution of Treatment to Death	
Group I	1	144	144	90
Group II	12*	46	44	53
Group III	11		34	54
Group unknown	37†	79	70	54
	29		50	54

* Includes 1 patient living 147 months.
† Includes 8 patients living over 100 months.

The records of 230 patients are included in Tables II, III, IV, V and VI. These records have been submitted to a group analysis in order to determine variations in the duration of life corresponding to the extent of the disease when the patient was first treated. Unfortunately, the records of many of these patients did not contain data concerning the actual extent of the patient's disease when first seen. These

have been included in the "Unknown Group." The number of patients in Groups I and II (Tables II, III, IV, V and VI) is too small to subject to a critical analysis. There were more patients in Group III. Table VII is the tabulation of the average duration of life in the patients in Group III, treated by various methods.

Dr. Louis I. Dublin,* of the Metropolitan Life Insurance Company, tested these data in an effort to find significant differences in the average duration of life between them. He tested for significance be-

* We wish to express our appreciation to Dr. Louis I. Dublin, Third Vice-President and Statistician, Metropolitan Life Insurance Company, for his help in analyzing the above data.

TABLE V

PATIENTS DEAD WITH CARCINOMA

Pre- and Postoperative Irradiation

	Total Number of Cases	Average Duration of Life in Months		Average Age
		Onset of Disease to Death	Institution of Treatment to Death	
Group I				
Group II	1	87	48	46
Group III	14	27	20	51
Group unknown	1	23	8	54

TABLE VI

PATIENTS DEAD WITH CARCINOMA

Irradiation Alone

	Total Number of Cases	Average Duration of Life in Months		Average Age
		Onset of Disease to Death	Institution of Treatment to Death	
Group I	1	72	12	86
Group II	2	54	49	74
Group III	34	48	24	59
Group unknown	4	22	25	59

TABLE VII

PATIENTS DEAD WITH CARCINOMA

Group III

	Total Number of Cases	Average Duration of Life in Months		Average Age
		Onset of Disease to Death	Institution of Treatment to Death	
Radical resection	62	41	31	48
Simple resection	12	46	31	50
Type of operation unknown	11	46	34	54
Pre- and postoperative irradiation	14	27	20	51
Irradiation alone	34	48	24	59

TABLE VIII

PATIENTS DEAD WITH CARCINOMA

Radical Resection and Postoperative Irradiation

	Total Number of Cases	Average Duration of Life in Months	Average Age
		Institution of Treatment to Death	
Immediate Postoperative irradiation (up to 6 weeks after operation)	36	30	48
Intermediate postoperative irradiation (7 weeks to recurrence seen)	25	38*	50
		33	50
Irradiation for recurrences and metastases	40	32	51

* Includes 1 patient lived 144 months.

tween: (1) cases with simple resection and cases treated by irradiation alone; (2) cases with simple resection and cases treated with pre- and postoperative irradiation; (3) cases with simple resection and cases with radical resection; (4) cases treated by irradiation alone and cases treated by pre- and postoperative irradiation; (5) cases treated by irradiation alone and cases treated with radical resection; (6) cases treated by pre- and postoperative irradiation and cases treated with radical resection. (Cases included under simple resection and radical resection, all received postoperative irradiation.) Dr. Dublin concluded, in each of the instances noted above, that the difference found between two types was too small, as compared with the fluctuation which must necessarily be expected from different samples, to allow one to draw any conclusions. In other words, from our limited data, there was no definite evidence of superiority for any one of the methods of treating breast cancer over any of the other methods. This does not mean that there actually exists no difference in the results obtained by the various methods. According to the findings of Dr. Dublin, we can only conclude that our samples are not large enough to establish any such definite difference.

These data were further subdivided in an effort to determine the influence of various

TABLE IX

PATIENTS DEAD WITH CARCINOMA

Simple Resection and Postoperative Irradiation

	Total Number of Cases	Average Duration of Life in Months	Average Age
		Institution of Treatment to Death	
Immediate postoperative irradiation	9	56*	54
		32	53
Intermediate postoperative irradiation	3	48	56
Irradiation for recurrences and metastases	10	47†	53
		35	52

* Includes 2 patients, 1 living 138 months, and the other living 147 months.
† Includes 1 patient living 147 months.

types of postoperative irradiation upon duration of life. Tables VIII and IX contain tabulations of the relationship between the various types of postoperative irradiation and longevity. The results in the radical resection group who received postoperative irradiation at various intervals are tabulated in Table VIII. It is apparent, from these data, that there is no significant difference in the average duration of life in the patients who were treated at various intervals after radical resection. Table IX presents the findings in the simple resection group. These data also suggest that there is no significant difference in the average duration of life among patients receiving irradiation at various intervals after simple resection.

Dr. Dublin's analysis of these data indicated that there was no significant difference between immediate and intermediate postoperative irradiation and irradiation for recurrences and metastases. Here again, he stressed the limitations of the data presented.

In preparing this presentation, we had occasion to study about 75 articles on carcinoma of the breast. The majority of the authors seemed convinced that early diagnosis and early treatment are necessary for good results. All seemed to agree that Group I patients should be operated upon, and that patients with inoperable recurrences and pain from bone metastases should be irradiated. The problem of most therapists seems to be the choice of the proper treatment for the large number of patients who fall between these two extremes. Some common denominator must exist for the proper handling of the patients in this intermediate group, which can be satisfactorily evaluated only from the study of large groups of cases. Should a patient with a Group III carcinoma of the breast be irradiated only or should the patient receive preoperative irradiation and surgery? Should surgery precede irradiation, and, if so, when should irradiation be instituted? If irradiation is given alone, should it be given in small doses in short treatment cycles or over a long, continuous period? If irradiation is given preoperatively, should treatment be a short cycle directed over the involved area or should it be over a long period? When should surgery be performed following preoperative irradiation? These are some of the problems which must be answered in order to find the most satisfactory approach to the treatment of cancer of the breast. It seems that the time is propitious for some large organization, representing radiologists and surgeons, to inaugurate one or several of the acceptable methods for treatment of cancer of the breast. In this manner, if careful records are kept, a sufficiently large number of patients, treated by several methods, could be accumulated in a few years for subjection to a critical analysis. If we carry on as we have been doing in the past, there will continue to be a marked divergence of opinion because of the small group of patients being reported by each individual, with the result that little progress will be made.

DISCUSSION

Having completed this statistical analysis, we were very disappointed in being unable to reach definite conclusions and recommendations for the treatment of cancer of the breast. Our data were subjected to every possible type of analysis, considering, among other things, duration and extent of disease; the type of malignancy, in some instances; the age of the patient; the nature of the operation performed; and the methods of irradiation. It was possible to compare the records of two patients with the same type of malignancy, the same degree of involvement, the same age, operated upon by the same surgeon, and all of the other controlling factors, in an effort to determine why one patient developed metastasis and the other continued to live. Many such comparisons were made and in no instance were we able to develop certain criteria that might assist us in determining further therapeutic procedures.

We have had the impression for many years that patients having a simple resection fare as well in their subsequent course as do patients having the radical operation. In addition, we have never been convinced that immediate postoperative irradiation offers more than delayed irradiation. While our data suggest that these impressions are true, the samples are not large enough to allow us to draw such uniform conclusions.

With the institution of preoperative irradiation, we were persuaded that at last a proper approach was being made to the breast cancer problem. While our experience with this type of therapy has been limited, it has not been through lack of cooperation on the part of our surgeons. Our experiences with preoperative irradiation have made us hesitate to recommend it routinely. The average duration of life, in the group of patients who received pre- and postoperative irradiation (Table v), was less than any other operated group. This short duration of life cannot be attributed to insufficient irradiation, as, in most instances, the carcinoma in the breast was materially affected, or completely destroyed. The difficulty seemed to lie in controlling the cancer in the axillary nodes, since doses as high as 6,000 r, measured in air, without back-scattering, produced negligible changes in them. Such experiences have made it impossible for us to recommend, with complete assurance, preoperative irradiation and the simple operation.*

* For discussion see page 421.

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SURGERY AND IRRADIATION IN THE TREATMENT OF CANCER OF THE BREAST*

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WILMINGTON, DELAWARE

CANCER of the breast, because of its relatively high incidence, presents a problem of constant interest to the medical profession. It has been estimated that 2 per cent of women die from breast cancer. Its treatment is universally acknowledged to consist of surgical removal, radiation therapy, or combinations of surgery and irradiation. Exactly what combinations of treatment shall be employed under various conditions is still highly debatable. The operative technique is fairly well standardized, but the same cannot be said for irradiation. We shall confine our discussion of the surgical treatment to certain technical procedures that have not been emphasized in the recent literature of mammary cancer.

The technique of irradiation which we have employed during the past eighteen months we believe to have a sound basis in the general principles of modern radiation therapy. It will be several years before the end-results of our method become apparent. Due to the rapid changes taking place in the growing science of radiation therapy, the development of improved physical equipment, and better knowledge of the biological effects of radiation, methods of treatment in use five or ten years ago are becoming obsolete. That we have the temerity to report a technique without statistical studies over a five to ten year period is a necessary corollary.

DIAGNOSIS

Detailed discussion of the diagnosis of mammary cancer is beyond the scope of this paper. We wish to put ourselves on record to the effect that in doubtful cases diagnostic aspiration biopsy as described by Martin and Ellis[13,14] has proved for us the most useful single method of making the diagnosis of cancer before operation. The success of aspiration biopsy depends fully as much upon the experience and cooperation of the pathologist as upon the skill of the surgeon. The pathologist cannot be expected to interpret minute fragments of tissue smeared upon a slide unless he is given frequent opportunity to study such specimens. Consequently, we perform aspiration biopsies for his benefit upon clinically obvious carcinomas as well as upon cases whose diagnosis is in doubt.

During the past two and one-half years our pathologist, Dr. Douglas M. Gay, has received from our staff 235 aspiration biopsies, of which 103 were obtained from the breast or its regional lymph nodes. In 96 cases the diagnosis was subsequently proved or disproved by tissue section or unquestionable clinical evidence. This series included 60 cases of cancer, in which a positive diagnosis was made in 49, and 36 benign lesions in which the correct diagnosis was made in 27; an overall agreement of 79 per cent. Insufficient tissue was reported in 11 cases; therefore, when sufficient tissue was sent to him the pathologist made a correct diagnosis in 89 per cent of breast aspirations.

Three of the four benign lesions reported as malignant were clinically adenofibromas and local excision only was performed. The other had an unnecessary radical mastectomy for diffuse chronic mastitis. On the other hand, we twice performed radical mastectomy in spite of a negative aspiration biopsy and found only diffuse chronic mastitis. We report these results of aspiration biopsy at length because of the pre-

* From the Carpenter Memorial Clinic for the Treatment of Cancer and Allied Diseases, Wilmington, Delaware. Illustrations by J. J. Renneck and drawings by M. Feinberg. Read in part at the Twenty-second Annual Meeting, American Radium Society, Atlantic City, N.J., June 7–8, 1937.

TABLE I

RESULTS OF ASPIRATION BIOPSY OF BREAST AND REGIONAL LYMPH NODES (1935–1937)

Final Diagnosis	Aspiration Reported Positive	Aspiration Reported Negative	Insufficient Tissue for Diagnosis	Total
Cancer	49	5	6	60
Benign lesion	4*	27	5	36
Percentage correct	92	84		89†

* One diagnosis very guarded, in a case of lactating adenoma.
† Cases with insufficient tissue omitted.

vailing impression that the method is suitable only for specialized cancer institutes. Our own experience indicates it is a valuable addition to the diagnostic facilities of a general hospital.

For those patients whose diagnosis remains in doubt after thorough examination and aspiration biopsy, we recommend wide local excision with the endotherm knife of the segment of breast involved, frozen section and immediate radical mastectomy if indicated. We employ the cutting endotherm knife, not because we believe it has any magic virtue in preventing local implantation, but because it cuts through fat and dense rubbery breast tissue more cleanly and sharply than any scalpel, dog-eared incisions do not result, less massage and trauma to the tumor occur. We are opposed to simple mastectomy

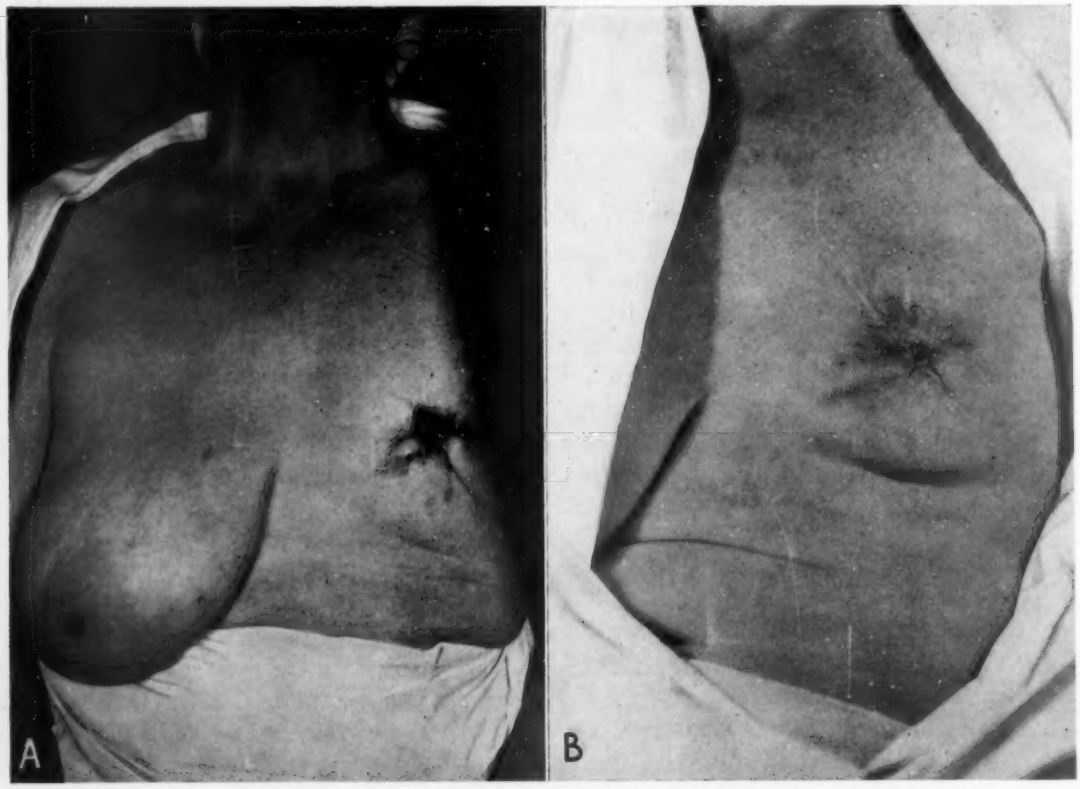

FIG. 1. Advanced cancer of breast of four years' duration. Patient also had metastasis to pleura, spine and pelvis which regressed under treatment. *A*. Before treatment by divided doses of hard roentgen rays. *B*. Eighteen months after treatment.

as a diagnostic procedure since potentially invaded lymphatics leading to the axilla are divided, while with local excision wide dissection en bloc is still possible.

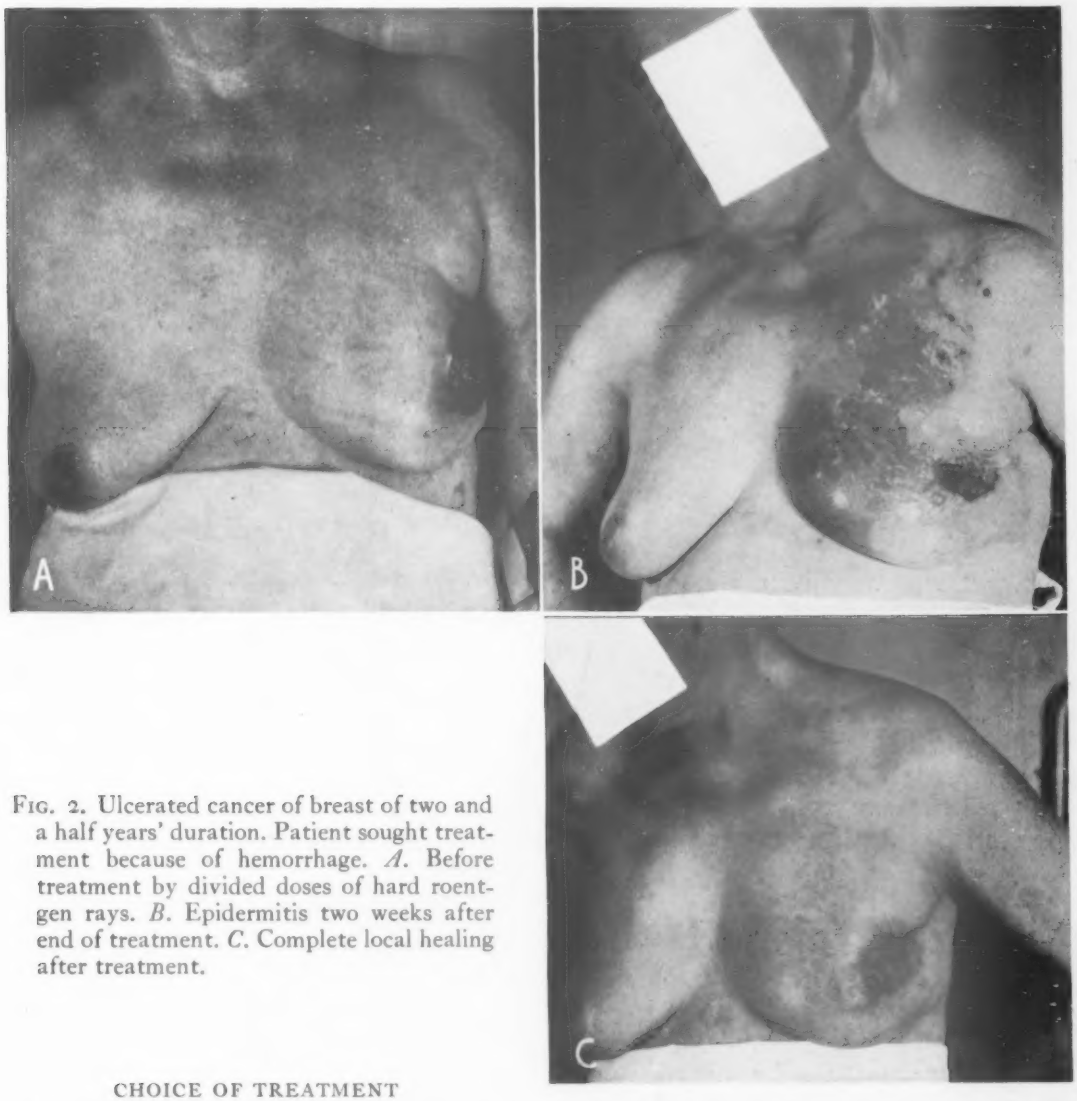

Fig. 2. Ulcerated cancer of breast of two and a half years' duration. Patient sought treatment because of hemorrhage. *A*. Before treatment by divided doses of hard roentgen rays. *B*. Epidermitis two weeks after end of treatment. *C*. Complete local healing after treatment.

CHOICE OF TREATMENT

Once the diagnosis of cancer has been established, we are faced with the problem of how best to treat the individual patient. The decision must be made as to whether surgery, radiation therapy, various combinations of these or no treatment at all shall be employed. The logical approach is: What treatment will offer the patient the longest and most comfortable life? Portmann[18] has recently re-emphasized the fact that life is frequently shortened by operation upon the advanced, incurable case, as Deaver pointed out many years ago. The criteria of Lee, recently restated by Adair,[1] are of value in classifying the individual case as primarily operable or inoperable. The patient's general physical condition and life expectancy should also be considered in planning treatment. Daland[6] and more recently Nathanson and Welch[17] have shown that the life expectancy of treated patients is only moderately greater than those untreated, particularly in the older age groups.

The usual contraindications to radical mastectomy need not be considered in detail. It should be obvious that women with fixed tumors, extensive skin invasion, fixed axillary nodes, supraclavicular or opposite axillary metastases, visceral and skeletal metastases, or inflammatory carcinoma, should not be subjected to an operation which is certain to leave behind active disease. Certain patients, naturally, will fall into the borderline group between operability and inoperability. The choice of treatment in such cases will depend upon the enthusiasm of the surgeon, and upon the alternatives at his disposal. The variation in five or ten year end-results reported from different surgical clinics reflects the rigidity with which the criteria of operability are applied.

The inoperable case, whether inoperability is due to poor general condition or to extensive disease, we treat by irradiation methods. We do not believe that inoperable breast cancer can be made operable by irradiation, even though marked regression occurs. In fact, if the tumor regresses markedly, one should conclude that it is radiosensitive, and one should persist along this line of treatment. Palliative mastectomy of advanced, sloughing breast cancers is seldom necessary. In our experience complete local healing usually takes place following roentgen therapy (Figs. 1 and 2).

SURGICAL TREATMENT

Since the modern radical mastectomy was introduced by Halsted and Meyer, good results have been obtained in the surgical treatment of *early favorable* cases. When the disease is confined to the breast, and has not invaded the axillary lymph nodes, most authors report about 70 per cent of five-year "cures." On the other hand, when axillary nodes are involved, various authors report from 15 to 30 per cent five-year "cures." It is in the latter group that surgical treatment alone offers a relatively poor prognosis. None the less, in the absence of the contraindications noted above, radical mastectomy should be performed, since a surgical cure may result provided axillary metastasis represents the farthest extension of the disease. Not infrequently enlarged axillary nodes prove to be free from cancer, and in other cases small metastatic nodes are found which could not be felt before operation. Claiborne and Foster[5] reported a 33 per cent error in both directions in their series of cases.

Local recurrence within the operative field is the fault of the surgeon. He must accept the fact that either the extent of the disease rendered it inoperable from the first, or he performed inadequate surgery on an operable cancer. In our own experience 2 patients who developed local wound recurrence had a second lesion in the breast, one 8 cm. and the other 20 cm. from the primary tumor, which were not recognized before operation. In each case the removal of skin and subcutaneous fat was inadequate with respect to the second lesion and recurrence resulted. A high percentage of local recurrence in the chest wall and axilla undoubtedly is due to the surgeon's willingness to operate upon advanced cases. The low incidence of local recurrence reported by Lee and Cornell[11] and Lee and Tannenbaum[12] may be explained by the fact that their "operable" cases were selected according to careful criteria.

Radical mastectomy is commonly performed by the Halsted-Meyer technique. The recent literature contains excellent articles on the technique of this operation by Harrington,[8,9] Bartlett,[4] and others. It is our purpose to call attention to another technique, the transverse incision described by Stewart,[19] and the indications for its use. During the past five years we have performed radical mastectomy upon 66 patients with primarily operable carcinoma of the breast. The Halsted-Meyer incision has been used in 21 cases and the Stewart incision in 45. We believe that the Stewart incision has a definite advantage over the Halsted-Meyer incision in the heavily dependent breast. It permits of a wider area

of skin removal when the tumor is situated in the outer segment of the breast. The axillary exposure is fully as adequate as in the Halsted-Meyer incision. Closure of the wound is more easily performed, and the surgeon is not tempted to preserve potentially invaded skin in order to obtain primary closure. The scar does not lie parallel to the anterior axillary fold, consequently the functional and cosmetic results are superior. When properly performed, the operation does not divide the lymphatic pathways to the axilla.

TECHNIQUE OF THE STEWART MASTECTOMY

An elliptical incision, widest opposite the tumor, is made through the skin. This incision usually extends across the midline anteriorly and to the posterior axillary fold behind. If the posterior angle is rounded rather than pointed, better wound closure may be obtained (Fig. 3). The superior and inferior flaps are dissected back in the plane of the superficial fascia, leaving just enough fat to maintain the nutrition of the skin. The depth of the incision is gradually increased until the rectus fascia is encountered below, and the upper part of the pectoralis major above, at the junction of its sternal and clavicular portions. The sternal portion of the pectoralis major is divided at its insertion into the humerus, retracted, and its sternal origins divided over clamps (Fig. 4). By this step the lymphatics perforating the anterior intercostal spaces are severed early in the operation, thus interrupting a potential pathway for mediastinal involvement (Bartlett, *op. cit.*).

The insertion of the pectoralis minor is next divided, exposing the subclavian pad of fat which lies anterior to and below the axillary vein at the point it disappears beneath the clavicle (Fig. 5). The fat pad in the subclavian triangle is dissected free, and all the axillary fat removed from above downward in the usual manner. When the axillary dissection is complete, the breast is severed from the chest wall, and removed in continuity with the axillary contents (Fig. 6). The axilla is drained through

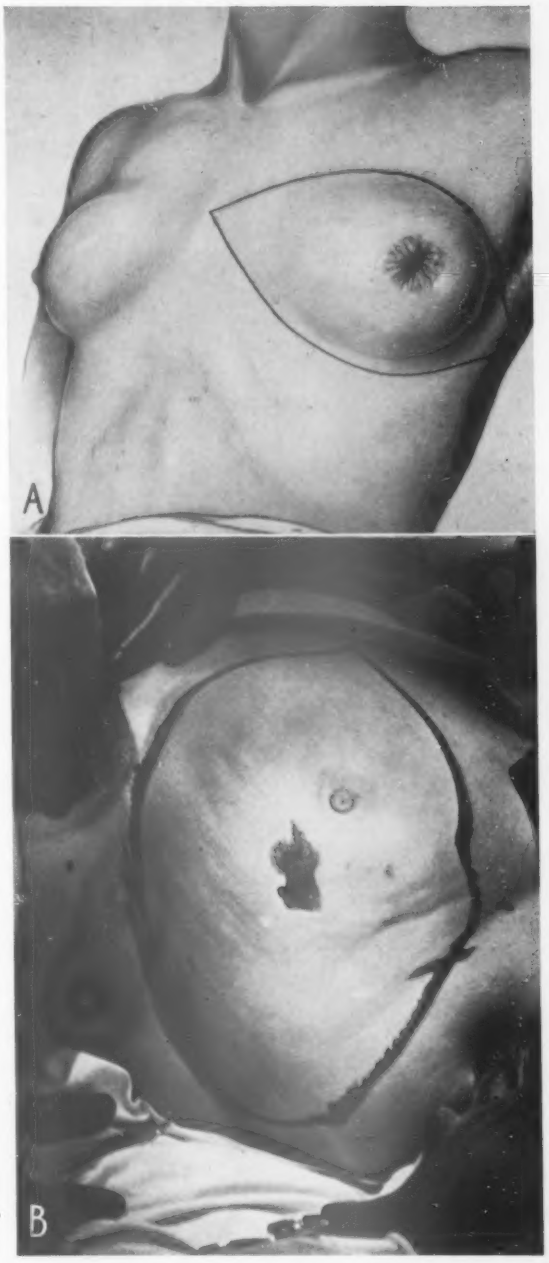

Fig. 3. The Stewart mastectomy: the incision. *A.* Anatomic relations. *B.* Photograph at operation. Marks on skin indicate the location of the tumor and the line of incision (note rounded posterior angle). This and the following photographs show the exposure obtainable through this incision in an actual case (Fig. 7). The anatomic drawings made at the same time are easier to interpret; the photographs demonstrate that exposure has not been improved by the artist's imagination.

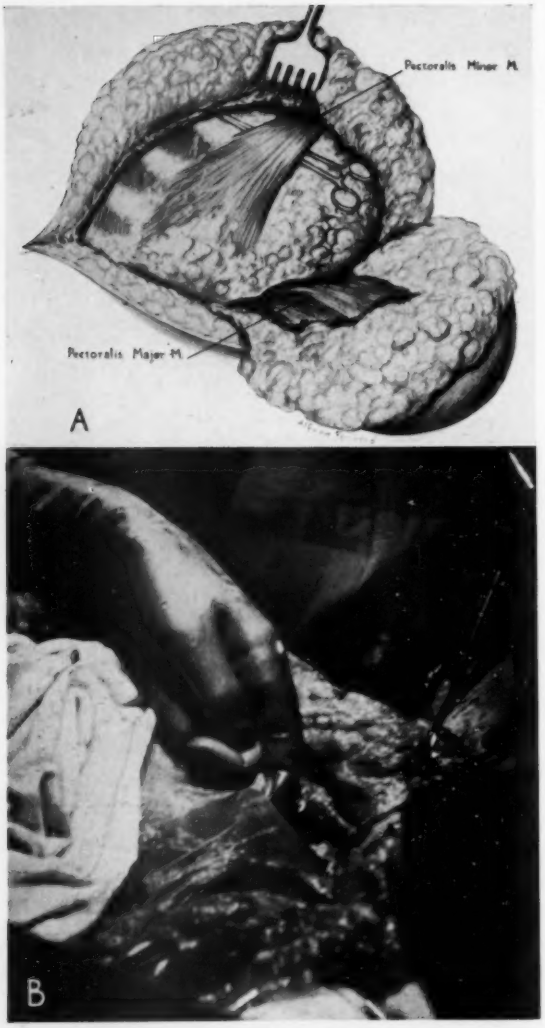

Fig. 4. The Stewart mastectomy: pectoralis major divided, pectoralis minor exposed. *A*. Sketch. *B*. Photograph.

the posterior angle of the incision. Wound closure is usually accomplished without tension although a wide area of skin has been removed, and healing is prompt (Fig. 7).

During the axillary dissection it has been our practice to mark the different levels with metal tags sutured to the fat (Fig. 5). The first tag is sutured to the subclavian fat pad described above, the second to the axillary apex and the third to the axillary base. In our opinion it is impossible for the surgeon himself accurately to identify the location of lymph nodes in the gross specimen after removal. The extent of axillary invasion is important both from the standpoint of prognosis and from that of postoperative irradiation. In 2 of our cases, invasion of nodes in the subclavian triangle was found without other involved axillary nodes, evidently by way of a direct lymphatic pathway which did not pass through the axillary chain.

PREOPERATIVE IRRADIATION

It has not been our practice to give routine preoperative irradiation. It remains to be demonstrated that any great improvement in five-year end-results will be produced by routine preoperative irradiation of breast cancer. At present we confine preoperative treatment to those patients who appear to have rapidly growing, highly malignant, and hence potentially radiosensitive cancers. The usual breast cancer is only moderately radiosensitive, and the dose of radiation compatible with subsequent operability is not uniformly cancericidal, as shown by the studies of Adair and Stewart[3] and Adair.[2] These authors found residual cancer in from 40 to 65 per cent of the breasts and

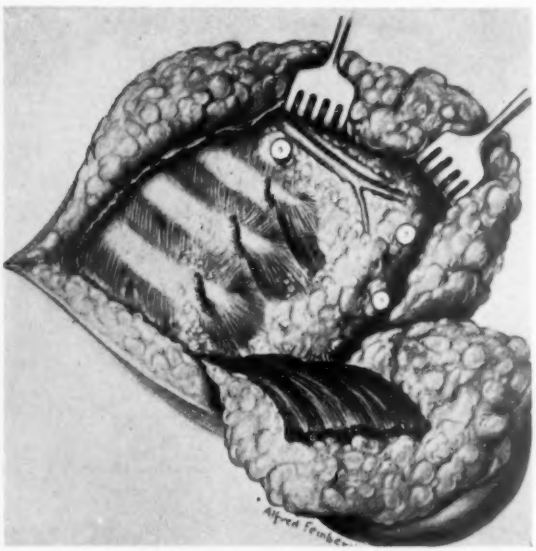

Fig. 5. The Stewart mastectomy: exposure of axillary contents is complete. Tags have been sewn in place to identify the lymph nodes at different levels.

in from 80 to 90 per cent of the axillae subjected to preoperative irradiation.

We believe that these results do not justify the long delay necessary before operation, and the increased morbidity after operation, except in unusual cases. It does not seem logical to waste valuable time in such uncertain treatment of a surgically accessible cancer. In the operable case neither cancer in the breast nor cancer in the axillary nodes causes death, but rather cancer beyond these regions. Why, then, should we give incomplete radiation therapy when complete surgical removal of the local disease is at our disposal? Should we not rather conserve the patient's tolerance for thorough, intensive irradiation of those regional lymph nodes beyond the reach of the surgeon's scalpel?

Radiation therapy of cancer should aim to cure when possible, or to alleviate the symptoms when cure is not possible. The preoperative irradiation of operable breast cancer is an unfortunate compromise between these two functions, unless future studies indicate a materially greater proportion of cures resulting from its use. Radiation therapy of the breast may be expected to cure cancer provided the dosage is sufficiently high. If we were to give from 7 to 10 erythema doses to breast and axillary nodes, subsequent surgical removal would be almost impossible, and in most cases, unnecessary. The difficulties involved in providing ideal and uniform irradiation, particularly in that truncated pyramid the axilla, and the severe, prolonged radiation reaction of the patient, make surgical removal more desirable.

POSTOPERATIVE IRRADIATION

There are many objections to the usual postoperative roentgen therapy, such as skin damage, radiation sickness, the production of pulmonary fibrosis, and, most serious of all, dosage which falls short of being cancericidal. In spite of these objections it is almost uniformly conceded that combined surgical and radiation therapy produces better results in the treatment of breast cancer than does surgery alone. Hutchison,[10] in a comprehensive review of the world literature, came to that conclusion. Yet the authors whom he quotes employed a wide variety of methods, most of them entirely inadequate according to present-day standards. Portmann[18] has pointed out that radical surgery dates from 1897, but "radical irradiation" has really developed since 1930, in the sense that it has become an actively carcinolytic treatment.

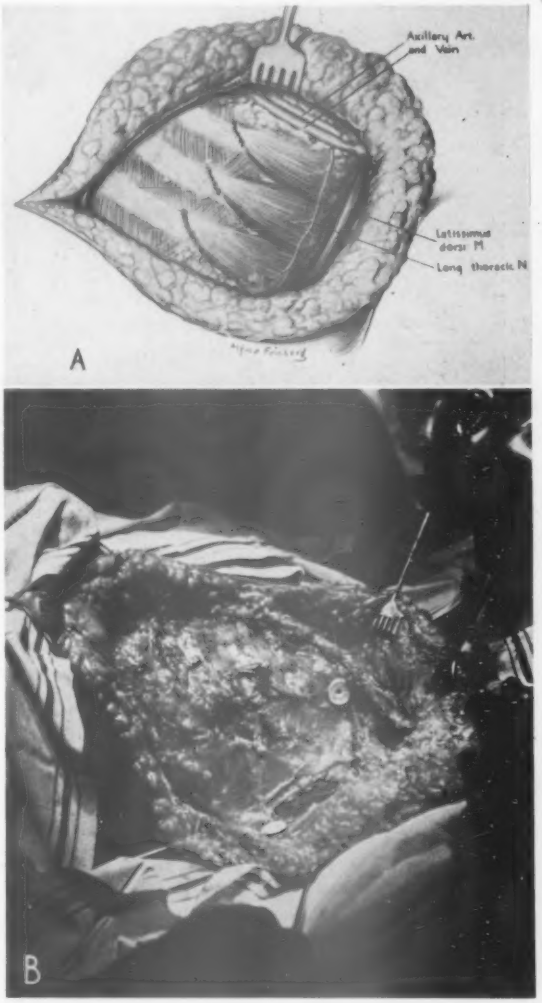

Fig. 6. The Stewart mastectomy: dissection complete. *A*. Sketch. *B*. Photograph, showing the bare axillary vein and tags placed at the site of subclavian and axillary base nodes.

The reported techniques of postopera-

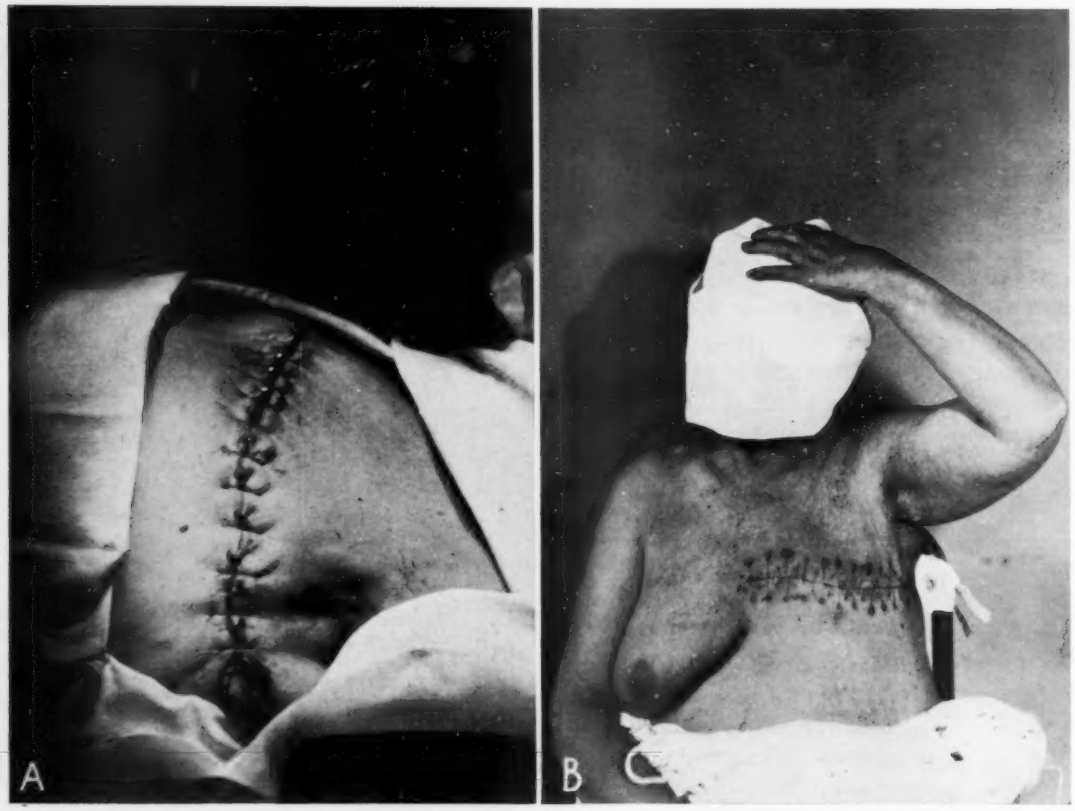

Fig. 7. The Stewart mastectomy: closure. *A*. At end of operation, wound closed without tension after wide skin removal (Fig. 3). *B*. On thirteenth postoperative day, wound healed except for drain site, shoulder motion good.

tive irradiation for breast cancer with which we are familiar have this defect in common: they attempt to treat the entire operative field as well as the regional lymphatics. It is our belief that the operative field is the responsibility of the surgeon. As Harrington[8] stated, the surgeon should remove the disease, not depend on radiation therapy to destroy the residue. Local recurrence should not occur in more than 10 or 15 per cent of cases if good judgment is used in the estimation of operability. The postoperative management of the operative field should be careful, regular, persistent follow-up examination, with radiation therapy only when and where indicated. When a local recurrence does appear, *in itself* it is no greater problem than any skin cancer, and should be treated intensively through a small field with a narrow margin of surrounding normal tissue.

We have attempted to devise a technique of postoperative irradiation on the basis of certain known or highly probable facts. From an anatomic standpoint it is important to know the distribution of the disease and the probable direction of its spread. Secondly, it is desirable to give a dose of radiation within the range known to be cancericidal. Finally, to give a dose of this magnitude, treatment must be confined to small skin fields, and full advantage must be taken of the Coutard method of divided dosage.

Treatment should be given under the assumption that unrecognized disease is present. "Prophylactic" treatment, to prevent the development of a cancer not yet present, is entirely illogical. Small or moderate doses of roentgen radiation cannot be expected to influence the average cancer if present, and are of no conceivable value if cancer is not present.

Reactive fibrosis has been postulated as one of the most important effects of postoperative radiation therapy of breast cancer. It is said to prevent recurrence by incarceration of the cancer cell. If this effect of irradiation is more important than its actual destructive action upon cancer, why is this not also true of cancer in other locations? Martin, Quimby and Pack[16] demonstrated that from 7 to 10 threshold erythema doses are necessary to control cancer of the oral mucous membranes and metastatic cancer of the cervical lymph nodes. Squamous carcinoma of the skin requires from 5 to 10 erythema doses to destroy it. Skin cancer that has been repeatedly irradiated with inadequate dosage frequently recurs in a dense fibrous bed and is then highly resistant to any treatment.

We agree with Portmann[18] that postoperative irradiation is unnecessary when no axillary metastases are found in the operative specimen, with one exception: the patient with a cancer of the inner hemisphere of the breast. A cancer in this anatomic location may metastasize to the nearer parasternal nodes before involving the axilla. Handley[7] has pointed out that the parasternal nodes along the course of the internal mammary artery frequently serve as a portal of entry for invasion of the thorax (Fig. 8). When axillary nodes are found to be involved, we treat both the supraclavicular and the parasternal regions.

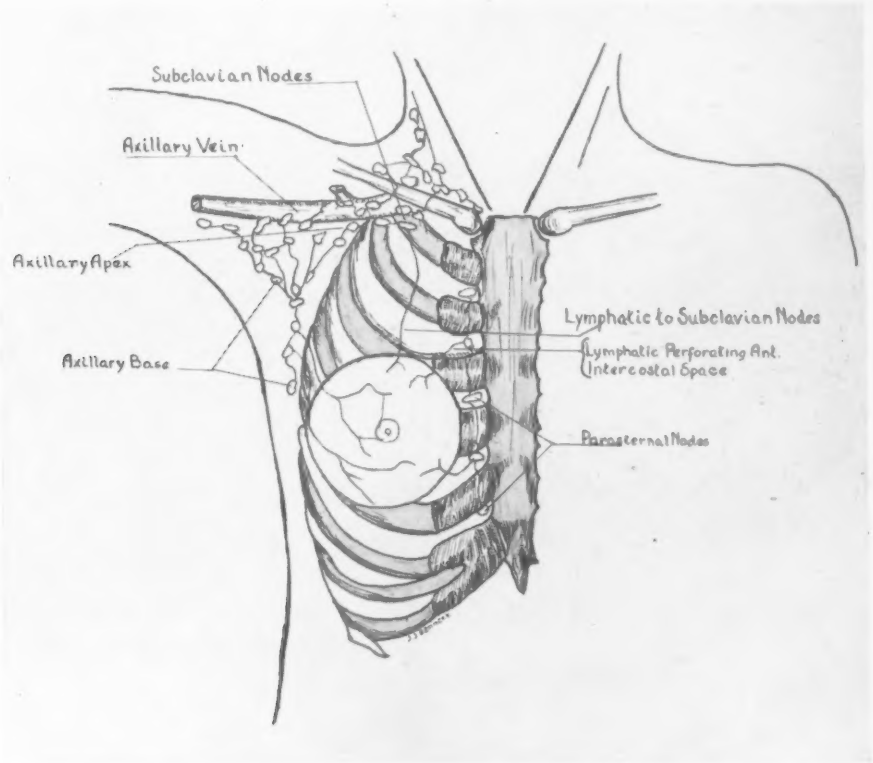

Fig. 8. Diagrammatic illustration of the chief regional lymphatics of the breast. The perforating lymphatics to the parasternal nodes accompanying the perforating branches of the intercostal vessels are usually described but seldom illustrated. They offer a pathway for metastatic invasion of the mediastinum and should be included in the plan of radiation therapy.

TECHNIQUE OF POSTOPERATIVE IRRADIATION

Deep roentgen therapy is given through two fields, one over the supraclavicular

nodes and one along the border of the sternum. Round or oval fields are employed, in order to reduce the area of skin and volume of deeper tissues irradiated. The value of reducing the area of the fields has been emphasized by Martin and McNattin.[15] It is particularly important when one plans to give a dose approaching the limit of tissue tolerance. Each field is given a dose of 100 to 200 r (measured in air) daily with the following factors: 200 kv., 25 ma., Thoraeus filter equivalent to 1.6 mm. of copper, target-skin distance from 50 to 70 cm. (usually 70 cm. in the case of the parasternal field.)

The size of the fields treated varies with the individual. The supraclavicular field extends from the lower border of the clavicle, where surgical dissection ends, upward to cover the supraclavicular fossa. It extends from the sternoclavicular articulation laterally to the border of the trapezius. It may be an 8 cm. circle or a 6×8 cm. or 6×10 cm. oval. The parasternal field extends from the first to the sixth rib, so as to include the upper five intercostal spaces, and from the midline of the sternum 6 cm. toward the involved side. Its usual size is 16×6 or 18×6 cm. (Fig. 9).

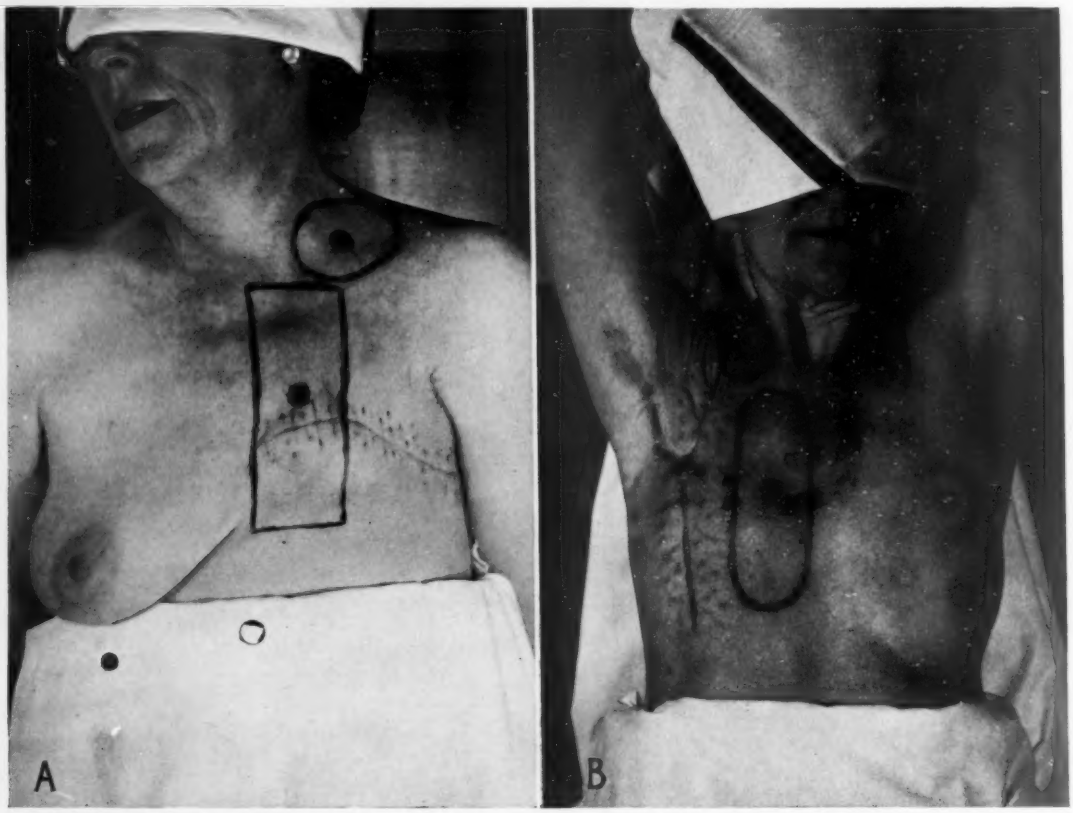

Fig. 9. Skin portals employed for treating the regional nodes only as described in the text. *A*. Stewart mastectomy. *B*. Halsted-Meyer mastectomy. (The rectangular parasternal field we no longer use but rather an oval field.)

The dose delivered to each field over a period of twenty to forty days is from 3,600 to 4,000 r, measured in air without backscattering. This dose is well tolerated, producing a moderate to severe epidermitis which heals with very little permanent change in the skin. We have treated 19 patients by this method during the past eighteen months with no complications such as radiation sickness, marked skin atrophy or pulmonary fibrosis. At times a

moderate bronchitis is produced which subsides after two or three weeks. In addition to radiation therapy of the regional lymph nodes it has been our practice to recommend roentgen castration for those patients who have not reached the menopause. The merit of this procedure has not yet been determined, and we do not insist upon it in all cases.

The important features of this method of treatment are the following: (1) The operative field is neglected in planning treatment, since presumably it has been adequately treated surgically. It is irradiated only when actual recurrence is discovered. (2) Accessible regional lymph nodes, potentially invaded by cancer, are treated through small fields accurately placed. (3) The fields are kept as small as possible to minimize local and systemic reaction. (4) Small daily doses are administered. (5) The total dose is as high as possible, approaching the lethal dose determined by Martin, Quimby and Pack.[16] (6) We do not use the commonly employed posterior axillary and posterior supraclavicular fields, since they are from 8 to 12 cm. from the supraclavicular nodes; consequently, the tissue dose delivered to the nodes is only slightly increased at a considerable sacrifice of local and general tolerance.

RADIUM TREATMENT

We have had no experience in the primary treatment of bulky breast cancers by interstitial irradiation. It has seemed preferable to give roentgen therapy through multiple fields, crossfiring the lesion. We have felt more confident of giving uniform irradiation by this method. If a residual tumor mass remains after external irradiation, especially when we are dealing with a small tumor difficult to treat through more than one or two fields, we implant radon seeds into the lesion. Single metastatic nodes appearing subsequent to mastectomy are more easily treated by the implantation of radon seeds than by a prolonged course of external irradiation. Radon implantation of nodes in the supraclavicular fossa frequently causes a severe brachial plexus neuritis characterized by pain, paraesthesia and paralysis in the corresponding arm.

We are opposed to the treatment of local recurrences in the immediate vicinity of the operative scar by interstitial irradiation. A dose of radon calculated to destroy the disease almost always produces a chronic radiation ulcer, since the skin lies immediately over the ribs and intercostal muscles without an adequate layer of subcutaneous fat. A superficial skin nodule may be treated by massive doses of unfiltered intermediate voltage roentgen rays (2,500 to 3,000 r at 140 kv.) or by a radium plaque at 1 cm. much as one would treat an epithelioma of the face. Deeper nodules usually respond well to divided doses of 200 kv. roentgen rays. Whichever type of treatment is chosen, we confine it to a small field about the recurrence and attempt to give a dose lethal to the cancer. We do not irradiate the entire operative field in treating a recurrence which may be only a few centimeters in diameter.

THE ULTIMATE RESPONSIBILITY OF THE SURGEON

The management of the patient with breast cancer presents a complex problem, of which one of the most confusing aspects is the decision as to who shall take the ultimate responsibility for her treatment. Certainly it is unfair for the surgeon to send her back to the referring physician with vague recommendations about roentgen therapy and follow-up examinations. In our opinion, it is the duty of the surgeon who aspires to operate upon breast cancer to familiarize himself with the details of radiation therapy. It is not enough for him to refer the patient to a radiologist. He should also know what type of irradiation she is to receive and be convinced that the proposed irradiation is adequate and proper. It is unfortunately still true that many roentgen therapists whose major training has been in roentgen diagnosis

and in roentgen therapy of benign dermatologic conditions are unwilling to give adequate "radical irradiation" for cancer. The ideal course would be for the cancer surgeon to prescribe and administer his own radiation therapy. When this is impractical he at least should inform himself as to what constitutes adequate treatment and insist that it be given. Finally, it is also his responsibility to follow the patient after treatment has been given, to detect and arrange for the treatment of recurrence or distant metastasis at the earliest possible date.

SUMMARY

(1) The results of aspiration biopsy for the diagnosis of breast cancer in a general hospital are reported.

(2) The value of definite criteria in differentiating between operable and inoperable breast cancer is emphasized.

(3) The Stewart incision for radical mastectomy is described in detail and its advantages stressed.

(4) A new technique of postoperative irradiation based on physical, biological and anatomical considerations is presented.

(5) In most cases the surgeon is responsible for the general management of the patient and consequently should be familiar with the methods of radiation therapy and the indications for its use.*

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* For discussion see p. 421.

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THE RATIONALE OF ARTIFICIAL MENOPAUSE IN CARCINOMA OF THE BREAST*

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DURING recent years much has been reported and written about the employment of artificial menopause in the treatment of carcinoma of the breast. Studies have consisted of reports of individual cases or small series, of results of castration in susceptible strains of mice, and of hormonological studies in relation to breast pathology.[10] Our approach to the problem has consisted first of all in an attempt to find out what differences can be observed in the disease in young women as contrasted with older women.

A series of postoperative cases of carcinoma of the breast observed at the Massachusetts General Hospital during the years 1921 to 1929 was divided into three age groups—146 cases forty-five years or younger, 303 cases aged forty-six to sixty inclusive, and 156 cases over sixty. The study was confined to the youngest and oldest groups, and roughly it may be said that the youngest group contained only women who had not yet passed the menopause, while those in the oldest group certainly had done so. It was found that carcinoma of the breast tended to metastasize earlier in young women (Table I) than in older women, and that it tended to be of a higher grade of malignancy (Table II). Postoperative recurrence seemed to take place more promptly in younger women

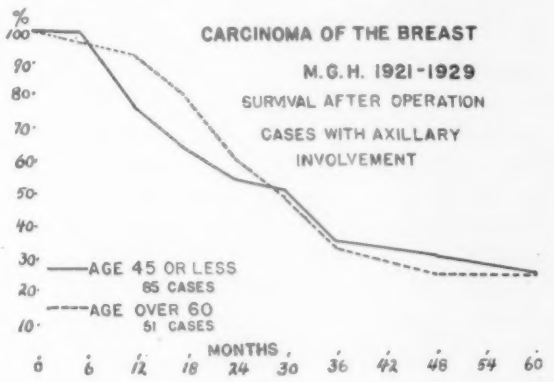

CHART I

(Chart I). The difference in cures, 34 per cent in the young group as contrasted with 44 per cent in the older group, seemed to be adequately accounted for by these differences in character and behavior (Table III).

TABLE I

AXILLARY INVOLVEMENT ON ADMISSION

Age	Under 46	Over 60
Axilla not involved	23%	43%
Axilla involved	77%	57%

TABLE II

PATHOLOGIC GRADE OF MALIGNANCY

Age	Under 46	Over 60
Cases	146	156
Grade I	7%	16%
Grade II	49%	56%
Grade III	44%	28%

TABLE III

CURES WITH RADICAL OPERATIONS

Age	Under 46	Over 60
Cases	117	113
Cures	34%	44%
Cures—Axilla not involved	71%	67%
Cures—Axilla involved	20%	21%

It was felt as a result of this study[11] that in carcinomas of the breast of equivalent extent and of equal grades of malignancy, age and menstrual status alone do not affect the curability of radical operation. It is probable, although not definitely proved by our study, that cases in young women are more likely to be inoperable when they are first seen, although depend-

* Read at the Twenty-second Annual Meeting, American Radium Society, Atlantic City, N. J., June 7–8, 1937.

able data on operability are difficult to secure.

Nathanson and Welch,[7] in their life expectancy study, offered curves which tend to show the poorer prognosis in young women as contrasted with old women; but the difference is not great, and one is more impressed by the similarity of their curves than by the divergence.

A current study of inflammatory carcinoma of the breast[12] at the Pondville Hospital shows no conspicuous alteration of the age distribution. This virulent method of growth is habitually assumed to occur chiefly in young women and frequently in association with pregnancy or lactation. Our group of 37 cases shows a normal age group for carcinoma of the breast in general, and in only one case was there any question of lactation associated with the origin of the disease.

The incidence of pregnancy during the course of carcinoma of the breast has been held to be of very grave significance, causing acceleration of the rate of growth. It has also been held that pregnancy taking place subsequent to apparent cure of the disease is of grave import, and likely to cause development of independent carcinoma of the remaining breast, or to stimulate the appearance of recurrences.[2,13] A current study (Adair and Meltzer[1]) of cases of treated carcinoma of the breast complicated by subsequent pregnancy does little to confirm these previously accepted ideas. Indeed these authors are of the opinion that pregnancy in itself does not seriously prejudice the outcome in adequately treated cases of carcinoma of the breast.

The effect of these studies, tending to minimize the gravity of pregnancy, to show that inflammatory carcinoma is as common in older women as in younger women, and to indicate that the difference in postoperative prognosis is not excessively great, is to narrow significantly our hopes and expectations from the use of artificial menopause as an aid in treatment, or as a prophylactic procedure against recurrence in carcinoma of the breast.

The earlier work on animal castration experiments, recently summarized by Taylor[9] and by Loeb and his coworkers,[6] emphasizes the significance of the hormonal background in the development of premalignant and malignant tumors in the breast. This work is further borne out by Herrell's[5] recent clinical study, suggesting that oophorectomy tends to diminish the incidence of carcinoma of the breast. None of these studies prepares us to understand the regressions of established metastases after artificial menopause, which have been described by numerous writers. To account for these regressions it is necessary to assume that in some cases a certain supply of the hormones is necessary for the continued growth of the tumor, and that removal of this supply causes inhibition or regression of the growth of the tumor. It is further reasonable to assume that the tumor growth can adjust itself to this lack after a variable period of inhibition, and that thereafter it can resume its previous activity. This would account for the regressions as well as for their usually limited duration.

Since the reports of Dresser[4] and of Smith,[8] we have been carrying out artificial menopause as a routine adjunct to our treatment of recurrent and inoperable cases of carcinoma of the breast at the Pondville and Huntington Memorial Hospitals.

In addition we have offered the procedure to postoperative cases as a prophylactic procedure, and have carried it out in about 50 cases. Dresser outlined his technique for this irradiation. We have had a few instances of resumption of menses which have required further pelvic irradiation, and accordingly we have increased the routine dose to 800 r to the front and back of the pelvis respectively, through a 15×15 cm. portal.

It is premature to attempt any report on the 50 cases who received artificial menopause as a postoperative prophylactic procedure. Of this group 9 are dead with recurrences, 5 of which involved the skele-

tal system; 4 others are living with supraclavicular or intrathoracic recurrence. In these cases with recurrence there is no evidence that the artificial menopause had any effect on the progress of the disease, or on the prompt appearance of recurrences.

Of the 50 cases of recurrent or inoperable disease, 36 patients are dead or show active progress of the disease, and 13 are getting along well with minimal evidence of activity of the malignancy. Again it must be repeated that this report is not a final study; that all these cases have been treated since Dresser's study in 1934, and that they are presented solely to permit a few inferences which seem permissible. Of this whole group of 50 cases, 20 have shown some possible or probable benefit as a result of the artificial menopause. It is difficult to be sure of the part played by the menopause when the recurrent focus of disease is itself subjected to intensive irradiation. Thus a true skeptic would perhaps disallow many of these possible benefits. Several cases, however, showed such striking improvement as to be convincing to anyone who saw them. We have not seen any cases such as those reported by Clarkson and Barker,[3] in which apparent cure was obtained. It should be borne in mind, however, that their cases were subjected to generalized irradiation, and that perhaps other factors were of greater importance than the ovarian irradiation.

In conclusion, we are confronted with a small sub-group of young women suffering from carcinoma of the breast in whom artificial menopause has shown striking benefit. It is suggested that the presence of the ovarian hormone in these cases is almost an essential condition for the growth of the carcinoma. The usually temporary character of the regression, and the eventual rapid progress of the growth suggests that the cancer can adjust itself in time to the lack of this growth stimulator. It would seem that this period of temporary maladjustment would be an opportune time to direct vigorous therapy to the discoverable foci of the disease.

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DISCUSSION ON PAPERS BY PENDERGRASS AND HODES, SPACKMAN AND HYNES, AND TAYLOR

Dr. Frank E. Adair, New York City. I wish first to congratulate the Program Committee on the type of papers presented in the symposium on cancer of the breast.

It seems to me Dr. Pendergrass and Dr. Hodes' paper is a very fine one. They have approached the problem at a little different angle than most of us would think of doing and it was very interesting, although the conclusions were disappointing. I had hoped that with

the years there had been a definite improvement in the five-year results obtained by roentgen therapy. It brings out the point that the technique changing from year to year makes it difficult to compare with radium therapy.

Dr. Spackman and Dr. Hynes' paper I thought very fine from the textbook standard. The incision of which Dr. Spackman is very fond I think he employs a little more generally than most of us do. In my experience it has been well to use the Stewart incision for the old women with pendulous breasts. There have been about twenty-four incisions described for breast amputation and we can take our choice.

One thing I was a little disappointed with in the paper. I think at this time it is premature to come to the conclusion that preoperative irradiation is without value. We have a great deal to learn about that and am sorry Dr. Spackman has gone as far as he has in this direction. A short time ago Coutard made the statement that his viewpoint is to give a preoperative course of roentgen therapy, to follow that by radical amputation and then by postoperative irradiation, and I understand that is the viewpoint of Dr. Pfahler, who has had an enormous amount of material to study through the years. I am inclined to think we will ultimately come to the latter conclusion. We have taken about 200 cases and subjected them to preoperative irradiation in an attempt to determine the carcinogenic lethal dose, if possible. It has been rather discouraging for it has been impossible for us to know what we will get when the specimen arrives in the laboratory. Dr. Ewing and Dr. Stewart have been very cooperative in the study. In the group where such irradiation is given we have obtained total destruction in 33 per cent of the breast cases; and in the axilla in 22 per cent. You may ask how we know that there was involvement of the axilla. The pathologists tell me that this was worked out several years ago. There is a definite microscopic picture of the node that has been involved in carcinoma. I thought that did not hold water, but I discussed it with Dr. Ewing and Dr. Stewart and they say this is true and is widely accepted now by pathologists.

Dr. Taylor's discussion of roentgen castration I thought was most illuminating and I was much impressed by it. I think all of us in a desperate situation have tried to force the facts. Dr. Taylor has been most honest and has tried to evaluate the facts. His results were largely like ours. I think many times we get striking temporary results from irradiation, but it sometimes happens that later the patients go on to a fatal outcome, which was only delayed. We had an interesting case which I had Dr. Hoffman report two or three years ago. The patient was a young woman who was going down hill rather rapidly. She had disseminated disease including metastatic nodules in the scalp. I told her brother not to bring her to New York any more for their local doctors could do as much as I could. About six months later they brought the patient in again. She had gained about 50 pounds and looked perfectly splendid. I was somewhat embarrassed, but in another six months she began to go down hill and was placed in the hospital. The nodules had decreased to small elevations on the scalp. She went on to death. We did a post-mortem examination and found she had become sterile from metastatic lesions in the ovaries.

Dr. George E. Pfahler, Philadelphia. When one comes to evaluate any method of treatment on the basis of clinical observations it is self-evident that we have a tremendous problem. I need not waste any time in convincing you of that for it is a recognized fact. Therefore, because of that difficulty we cannot draw absolutely positive conclusions either one way or the other.

Taking the first paper by Dr. Pendergrass and Dr. Hodes, I certainly think we must all congratulate these authors and accept their statistics as accurate. I hesitate to discuss them because of the high standing of these men and also because these data have been in part produced by our distinguished friend and former president, Dr. Henry K. Pancoast. Therefore we must accept two facts in this connection: First, that the work has been well done. Second, that the statistics have been well prepared and they have been reviewed by the statistician of the Metropolitan Life Insurance Company. But, after all, it depends upon what you put into the statistics as to what conclusions you draw. First of all, who has ever judged the value of the treatment of pneumonia by making an analysis merely of the deaths from pneumonia? You must also judge the value by the number who survive. Also, we would not evaluate the operation on carcinoma of the stomach, for example, by the number of patients who

die from that operation. The best technique or the best method of treatment is better indicated by the recoveries. I believe, therefore, that these unfavorable results do not contradict the evidence that has been produced by other men who have used the same kind of statistics and have arrived at different conclusions, because they have studied the patients who got well in proportion to those who died. In Drs. Pendergrass and Hodes' records the patients all died. They must have had others who got well.

As you saw by the diagrams thrown on the screen, there were many portals of entry for the rays, many more in former years than at the present time and gradually these numbers have been decreased. If there is any value in employing multiple portals it lies in the fact that we are crossfiring from these portals and thus increase the relative depth dose. In the cases that were shown on the diagrams there was almost no crossfiring. In addition they had the fields divided and there were bound to be little spaces between these fields in which there is less irradiation and perhaps none. I had the privilege only about a month ago of demonstrating before some of our graduate students a case of melanotic carcinoma which had involved the entire surface of the left leg of a man, extending all the way from the plantar surface up to and involving the groin. Under heavy irradiation these lesions disappeared. There was desquamation of the skin and then, after a period of about four months, I was able to demonstrate to the students a group of three nodules that just exactly filled the space between two fields. That convinced me that we have to be very careful in the crossfiring that no space is left that does not receive irradiation. I, like Dr. Pancoast, many years ago used multiple fields something like these illustrated but I have long abandoned them and at present do not multiply fields unless I can get some crossfiring. For example (illustrating on blackboard) if we are giving preoperative irradiation we can get some definite value in crossfiring by taking the field from the median line or at least the parasternal line to the nipple line and the direct rays tangentially. This can be helped by filling up the space here (indicating) by wheat bags or rice bags. Then you can turn the patient over on the side and can again crossfire from the midaxillary line into the breast tangentially. We crossfire through the axilla and the coracoid and supraclavicular regions. These rays branch out into the mediastinum and supraclavicular glands. In this manner we reach the carcinoma of the breast, the axillary lymph nodes and the supraclavicular nodes, which is the most common line of extension. We will get approximately the same amount of irradiation in the deeper tissues as we get on the surface. If we have a stout patient we can turn her around and get some additional effect in the axilla from the outer posterior axilla. In this way we get the crossfiring effects and we get results, but merely multiplying fields and giving the treatment in a rather indefinite manner does not mean that you are multiplying the real effects.

My idea of preoperative treatment is that of giving the patient just enough treatment to devitalize the more malignant type of cells. You can get that effect in a period of two weeks and with about 900 r, which you can give in that time, and you get about the same dose in the deeper tissue. That amount of treatment will not destroy the more resistant type of carcinoma cells but, as has been shown by Harrington in 2,390 cases 91 per cent belonged to Grades 3 and 4. Therefore, when you have such a high percentage of Grades 3 and 4 carcinoma you should have some effect from irradiation, even with only 900 r. That is why I believe it should be given in a two-week period. That time is not a long delay and I would prefer to take the risk of that much delay.

The patient should be operated upon during the third week. Then we have the postoperative treatment which can follow the operation usually within a period of three weeks. If the patient has not had preoperative irradiation the postoperative treatment should usually begin two weeks after the operation. With postoperative treatment we crossfire as before. We cannot crossfire directly into the axilla for the patient cannot raise her arm, so we make use of the postaxillary field, sending the rays sufficiently through the posterior wall to get the radiation into the axilla, deep clavicular area and mediastinum. For all this I use high voltage therapy. For the treatment of the mammary region I see no reason for crossfiring and here I think we should carry our field from this infraclavicular line extending from the axilla to the lower border of the inner end of the clavicle, and carry that opposite to the parasternal line down to the ensiform and to

the axillary line. I see no use in crossfiring there, nor do I see any reason to use the high voltage roentgen rays there. You want no damage to the lung and as little to the heart as you can get and I use the low voltage 125 kv. and apply radiation to the extent of an erythema dose according to the saturation technique. My aim is to give all these areas, counting the preoperative and postoperative irradiation, a total of 1,800 to 2,400 r.

I have been working with roentgen therapy and postoperative irradiation in carcinoma of the breast for thirty-five years. We have followed our patients which are alive five years following preoperative irradiation, surgery and postoperative irradiation. These have all been studied on the basis of Grades 1, 2 and 3. In Grade 1, 81 per cent are alive. They were operated upon within thirty days after beginning the roentgen therapy. In Grade 2, 56.5 per cent are alive, in Grade 3, none is alive. Of those patients who were operated later than thirty days after beginning irradiation in Grade 1, 50 per cent are live; in Grade 2, 71 per cent.

Taking all cases without regard to when they were operated on following irradiation, in Stage 1, 73 per cent are free from the disease at the end of five years; in Stage II, 57 per cent are free at the end of five years. In the postoperative cases, those treated between 1902 and 1922, in the group with glands there were 46 per cent symptom-free at the end of five years. In the group from 1922 to 1932 in Stage 1 there are 72 per cent, which is approximately what you get with operation. In Stage II, 50 per cent of cases treated prior to five years ago, 52.4 per cent. If all dead and uncured patients are eliminated we still have 45.5 per cent; of the cases receiving both pre- and postoperative irradiation, 51 per cent.

I am convinced of the value of both pre- and postoperative irradiation.

Dr. Norman Treves, New York City. The papers of the morning have been most interestingly presented and the essayists are to be congratulated. It was comforting to me to hear Dr. Pendergrass indicate the lack of uniformity in the irradiation technique for the treatment of mammary carcinoma. In the many clinics that are working on this phase of radiation therapy, it would seem that the time had arrived for some unanimity so that our statistics may at some future date be properly evaluated.

In the treatment of breast carcinoma the only procedure in operable cases that is universally accepted is radical mastectomy. The value of preoperative and postoperative irradiation has yet to be proved. The irradiation technique should be standardized as the surgery is. The number of ports, the sizes of the fields, the distances and filters used are all so varied that we are deprived of a basis for comparison.

I have been interested for many years in "inflammatory carcinoma" of the breast. Dr. Taylor stated in his communication that this type of mammary cancer was peculiar to young women. When the late Dr. Burton J. Lee and I reported our cases in 1924, we found the average age of the 28 patients to be 44½ years. We are in agreement with Dr. Taylor's statement that he has never observed a case during pregnancy or lactation. Neither have we.

I was particularly interested in Drs. Spackman and Hynes' paper and believe a number of their statements bear repetition: First, that the value of pre- and postoperative irradiation still has to be proved. Second, they question the value of aspiration biopsy in doubtful cases. It seems to me that the doubtful cases are the difficult ones to prove by this method, for the tumors are usually quite small. These patients, I feel, should not be subjected to aspiration but to wide local excision with examination in the operating room. I disagree with these authors in stating that the line of incision, in excision or local mastectomy (for diagnosis), passes through potentially invaded lymphatics. This theory might hold good if one believes in Handley's permeation theory—but I do not believe that we do.

In the next place Dr. Spackman states that inoperable carcinoma cannot be made operable by irradiation. We all should concur in this dictum. A marked clinical regression following the use of physical agents means, as a rule, a high index of malignancy. In these cases radiation therapy alone should be used.

Local recurrences in the operative field are the surgeon's fault. Either he failed to recognize that the case was inoperable at first or his surgery was inadequate. Lee and I reported an analysis of 363 patients with recurrent inoperable carcinoma and found that 19 per cent had, as the initial recurrence, a solitary chest wall recurrence or diffuse cutaneous nodule. Drs. Spackman and Hynes refer to the group of

75 operable cases reported from the New York Hospital by Lee and Cornell, emphasizing the few local recurrences observed. They failed to indicate what is most important—that the surgery was well planned. Even in this group of "hand-picked" cases the five-year survival was 15 per cent.

The use of the Stewart incision should not be employed to the exclusion of all others. Like other operative procedures, it has its place. But the incision to be used depends entirely on the size and topography of the breast and the tumor. The value of severing the sternal portion of the pectoralis major muscle early in the operation is indicated for two reasons: it severs the anterior perforating lymphatic vessels of the chest wall and, what is more important, it facilitates the exposure of the apex of the axilla. The authors remark that if good judgment is used as to operability local recurrence should not occur in more than 10–15 per cent of the cases. This figure is entirely too high.

In the two-portal setup which these authors have used for postoperative radiation therapy it would appear that they are delivering roentgen rays to the superficial lymphatics in the parasternal area and the substernal and hilar nodes. The dose employed may be therapeutically effective externally but if nodes are present within the chest I doubt that the treatment employed will be more than palliative.

The group of cases reported on is small and the longest time which has elapsed since treatment began is eighteen months. Consequently we must wait for a review of the cases, at a later date, to prove the effectiveness of their methods.

Dr. Henry Schmitz, Chicago. The views on the clinic and treatment of carcinoma of the breast are so divergent that one hesitates to enter into a discussion. To me, it appears that we will never come to any agreement until we study the extent the carcinoma of the breast has reached. As long as only the regional lymph nodes of the first line of defense are invaded, the prospects of satisfactory end-results of treatment are good. However, when the second line of defense is involved, that is the supraclavicular, the opposite axillary, the mediastinal and the inguinal lymph nodes and the viscera, particularly of the thoracic cavity and the abdomen, then all prospects of even palliation are gone. We have divided the extent of disease of carcinoma of the breast into four groups just as we have the carcinoma of the cervix and the uterine body. They are: clinical Group I, the clearly localized carcinoma which should not be larger than 2 cm.; clinical Group II, the doubtfully localized carcinoma which is larger than 2 cm., and has a dough-like periphery as if it were sending roots into the breast tissue; clinical Group III, the invading carcinoma which invades either the skin anteriorly, the pectoralis major muscle posteriorly, the axillary and infraclavicular lymph nodes or substernal lymph nodes, but the breast as well as the glandular invasion must be movable; clinical Group IV, the fixed or disseminated carcinoma. The fixation comprises either the breast to the chest wall or the glands to the surrounding tissues or structures and ulceration of the skin, and of course invasion of the lymph nodes of the second line of defense, or the viscera.

I shall not enter into a discussion of the mode of dissemination as this would lead too far. It is our opinion that radiation therapy of carcinoma of the breast should be confined to Groups II and III, and if the surgeon intends to operate on these patients the treatment should be given first and operation follow within eight weeks from the cessation of treatment. At this time the irradiation reactions have been completed.

The technique which we use consists in tangential fields if the tumor is located in the outer half of the breast, and anterior and posterior fields through the entire chest, including the lung, if the tumor is confined to the inner half of the chest, when one must consider the possibility of invasion of the substernal lymph nodes and finally the mediastinum. We have confined radiation therapy entirely to roentgen therapy and our attempt is to permeate the entire cancer-bearing area with a homogeneous dose of at least 4,000 r, using 800 kv. We find that the results of treatment are superior to those of low voltage. We are now contemplating dispensing with the operation entirely in the Groups II and III cases, as we have had quite a number of patients with primary carcinoma of the breast who could not be operated upon on account of absolute contraindications, and who have remained well without operation. The primary tumor either disappears entirely or contracts to an inert scar mass. We have patients treated three or four

years ago in whom the cancer has been completely arrested. Whether they will reach the five-year mark, of course I do not know. I wish to say that four-year end-results in the treatment of carcinoma of the breast with 800 kv. roentgen rays with or without operation afterwards have been 51.2 per cent.

Dr. Pendergrass (closing). I wish to thank all of the discussants for their remarks. This paper has brought out just the type of discussion I had hoped for. I am sorry that time and friendship interfered with Dr. Pfahler's telling you just what he thinks of me. I do not think he meant, however, that he was not interested in the dead patients. If you followed the results that he presented you know that he has 80 per cent of his patients alive five years after treatment. On the other hand, 74 per cent of our patients are dead, so I am very much interested in that group. I stated that all of our patients had carcinoma and all of them died with carcinoma. The second thing I tried to stress was that I could not draw any conclusions. The third thing was that I made a plea that some effort be made by this organization to study this subject and see if we can arrive at some common denominator by which this problem can be approached.

I did not take up your time to discuss in detail the radiation technique but in the paper it is discussed and if our technique and that of Dr. Pancoast is indifferent, as Dr. Pfahler has said, then you can evaluate our results in the light of the therapy given. My slides, because of technical difficulties did not indicate the crossfiring that Dr. Pfahler thought so significant. I assumed that you would give me credit for crossfiring when it was indicated. That has been an acceptable method for years. When the radiation was directed over to the contralateral side, that was for prophylactic reasons.

Dr. Hynes (closing). I should like to make clear our position with regard to preoperative irradiation. Dr. Adair suggests that we have discarded it. It is true that we seldom employ preoperative irradiation, but in special cases we have done so and probably will continue to do so. We feel that marked improvement in end-results is still to be demonstrated. We have chosen to treat most of our relatively small group of patients according to the technique described in order to determine the value of concentrating therapy on certain small areas where lymphatic invasion is likely to occur. It is our intention to report this series of patients again when the end-results become apparent.

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RADIATION TREATMENT OF CARCINOMA OF THE LUNG*

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AT THE end of the nineteenth and at the beginning of the twentieth century two opinions prevailed in regard to the incidence of primary carcinoma of the lung. The first was that the disease was very rare and the second that primary carcinoma of the lung and pulmonary tuberculosis do not coexist.

Twenty-five years ago I became chief of the Cancer Division of the Montefiore Hospital, in New York, a hospital for chronic disease. At the same institution the tuberculosis division was under the direction of the late Dr. M. Fischberg, a noted phthisiologist. I was immediately impressed by the fact that practically all the admission to the cancer division of cases of primary carcinoma of the lung were transfers from the tuberculosis division. Very rarely were cases admitted directly to the cancer division with a diagnosis made before admission. This showed that even in a progressive medical center like New York, primary carcinoma of the lung was not recognized. Furthermore, the autopsies demonstrated that not only did carcinoma of the lung and pulmonary tuberculosis coexist, but we have encountered the development of a primary carcinoma in the wall of a tuberculous cavity.

This cooperation between these two departments served not only to disprove the opinion that primary carcinoma and tuberculosis do not coexist but also seemed to indicate that the rarity of primary carcinoma of the lung half a century ago and the recent increased frequency of the occurrence of the condition are not real but only apparent. A number of pathologists attempted to prove the true increase of frequency by autopsy findings. Autopsies performed in the same hospital showed a greater percentage of cases of primary carcinoma of the lung in more recent years than previously. However, by the time a case of primary carcinoma of the lung reaches the autopsy table the condition is surrounded and complicated by so many additional pathological conditions in the lung that the primary tumor may be overlooked, particularly if the pathologist is not cancer-minded as was the case at the time. Arkin and Wagner[1] in their report show that lobar pneumonia and bronchopneumonia are present in 28 per cent of cases of primary carcinoma, chronic pneumonia in 20 per cent, bronchiectasis in 43 per cent, abscess or gangrene in 20 per cent.

In view of all this, it is evident that the increased frequency of the occurrence of primary carcinoma of the lung is apparent only and is due to refinement in the diagnostic methods and the greater interest of clinicians and pathologists in the condition.

Twenty-five years ago when I began my study of primary carcinoma of the lung, the interest was only academic since no attempt at therapy could be considered. My investigations consisted in attempts to correlate the microscopic appearance of the tumor with the symptomatology and the clinical course of the disease. However, no difference was noted in the clinical course and gross pathological appearance of the tumor whether it was, microscopically, an *adenocarcinoma*, *squamous cell* or *undifferentiated cell carcinoma*. Later I attempted to compare the roentgenologic appearance of the lungs with the gross pathologic appearance of the same lung obtained later at the autopsy. While a certain check on the course of the disease was obtained, the investigation was of no practical importance since all the work had to be done on far advanced cases. The following case may illustrate the complexity of the problem.

* Read at the Twenty-second Annual Meeting, American Radium Society, Atlantic City, N. J., June 7–8, 1937.

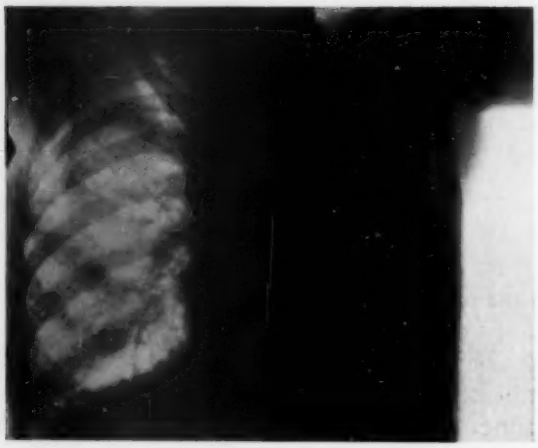

Fig. 1. Case 1. Roentgenogram of chest shows diffuse density in the left side of chest.

Case 1. A. H., male, aged thirty-nine, was admitted to Montefiore Hospital on March 22, 1915, complaining of pain in the right side of the chest, dyspnea and cough. He gave a history of having been treated in a tuberculosis clinic for the last nine months. *Examination* showed on percussion of the right side of the chest dullness everywhere and on auscultation there was noted bronchial breath sounds and many râles. Roentgen analysis showed a diffuse density which completely obstructed all the structure of the left side of the chest. There was no evidence of any fluid in the pleura (Fig. 1). Enlarged lymph nodes were present in the left side of the neck. A biopsy of one of the lymph nodes showed a papillary adenocarcinoma (Fig. 2). The patient died seven weeks later. At autopsy the left lung showed carcinoma replacing much of the upper part of the lung and pleura. The carcinoma in the lung was surrounded by lobar pneumonia. Near the apex was found a large cavity into which opened the branch bronchi. The main bronchus was constricted by tumor tissue. The bronchial and mediastinal lymph nodes showed both tuberculosis and carcinoma (Fig. 3).

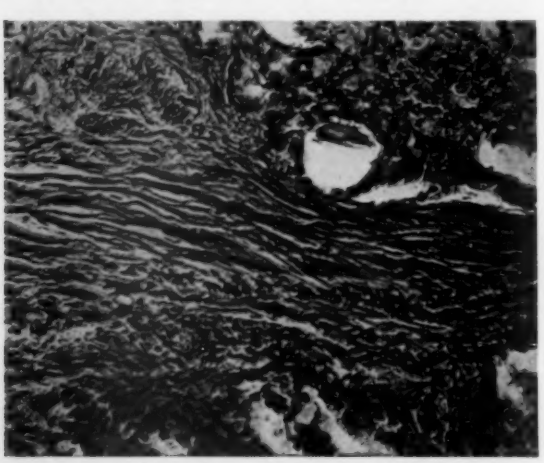

Fig. 2. Case 1. Photomicrograph shows papillary adenocarcinoma.

Fig. 3. Case 1. Gross specimen of lung which shows solid carcinoma and pneumonia side by side.

Comment. Evidently there was a combination in this case of actual tuberculosis with cavity formation; carcinoma of the main bronchus which supervened much later and lobar pneumonia, which was terminal.

DIAGNOSIS

The first attempts at therapy of primary carcinoma of the lung either by surgery, irradiation or combination of both, were of very recent date. These attempts immediately created the problem of whether the condition could be diagnosed early enough in its course to make it amenable to treatment.

Two phenomena in connection with the clinical course of the disease make an early diagnosis exceedingly difficult. In the first place, the disease is usually silent in the early stages of the development and

produces no symptoms until the advanced stage is reached. What is of greatest importance from the standpoint of therapy is the fact that metastases in distant organs develop very early in the course of the disease and before symptoms of the primary condition in the lung become evident. As a result the symptom-complex and the chief complaints of the patient are frequently due to the metastatic tumors and not to the primary condition in the lungs. Thus the main reason why the clinician fails to make a diagnosis of primary carcinoma of the lung in its early stages is that the patient is usually not aware of any abnormality at that stage. The next difficulty consists in the fact that in its earliest stages the condition cannot be discovered by any diagnostic methods at our command. These methods consist in *auscultation* and *percussion* of the chest, *bronchoscopy* and *roentgen examination*.

Clinical analysis shows the presence of a new growth in the lung only when the condition is well developed, though atelectasis in one lobe may be present and create at least a suspicion of malignancy when the tumor is very small and located in the main bronchus. Usually, however, the physical signs at the beginning of primary carcinoma of the lung in its center, periphery or even at the main bronchus, when there is no bronchial obstruction, are few since the tumor is covered by a layer of normal pulmonary tissue. The tumor has to reach a certain size in order to produce flatness on percussion and absence of vesicular breath sounds on auscultation. In view of this lack of physical signs, it is very important for the clinician to keep in mind that when a patient past middle age comes with symptoms of cough, hemoptysis, pain in the chest and dyspnea, and the results of the examination are negative, the possibility of the presence of a primary carcinoma of the lung must not be immediately excluded but the patient should be reëxamined at frequent intervals.

Bronchoscopy. Positive finding on bronchoscopy, particularly if it is accompanied by a biopsy, represents the most conclusive diagnostic evidence, but it does not give any information as to the extent of the disease and is therefore of no assistance in the determination of the prognosis and the selection of a therapeutic procedure. Negative finding on bronchoscopy is of no diagnostic value. Again in bronchoscopy the best diagnostic results are obtained in the well-developed advanced cases. Clerf[3] reports that of 143 cases which had a bronchoscopy done, only 5 cases could have been considered as suitable for surgical treatment.

Roentgen examination of the chest is undoubtedly the best single diagnostic method in primary carcinoma of the lung. However, even in fully developed carcinoma it is frequently difficult to make a correct diagnosis by roentgen evidence alone. When there is present an area of infiltration at the hilum surrounded by an area of atelectasis the presence of a malignant tumor is fairly certain, but such a combined roentgen picture indicates a far-advanced condition. When central necrotization takes place it is impossible to differentiate between carcinoma and abscess of the lung. Edwards[4] states that in a series of cases diagnosed as abscess of the lung, and subjected to operation, the abscess was found, in 10 per cent of the cases, to have arisen within a primary carcinoma. When pleural effusion is demonstrated, roentgenologically, it aids in the diagnosis, but this shows again a further advance in the stage of the disease. Paralysis of the diaphragm on the involved side helps to establish the diagnosis. A neoplasm developing in the middle or periphery of the lung is very difficult to differentiate from a simple unresolved pneumonia by roentgenologic appearance. A secondary bronchiectasia or infection may obstruct the primary condition, though the injections of iodized oil may assist in clearing up these conditions. A really early primary carcinoma of the lung which begins at the root of the lung may be so hidden by mediastinal structure that it cannot be demonstrated on the roentgenogram and the same is undoubt-

edly true of very early beginnings in the parenchyma of the lung.

From our own clinical experience to date, it is impossible to estimate the length of time which it takes for the development of primary carcinoma of the lung from the early invisible stage to a fully developed tumor. As was shown above, in a large percentage of cases there never appear any symptoms of a pulmonary involvement, and where such symptoms do appear they probably manifest themselves only in the late stages of the disease. However, a comparison with the development of *metastatic carcinoma of the breast* may serve to clarify, to a certain extent, the situation. The clinical course of carcinoma of the breast resembles, in many respects, the course of primary carcinoma of the lung. In both conditions metastases develop, in the majority of cases, in the early stages of the disease and occasionally even before the primary condition becomes evident. I make a roentgen examination of the chest and skeleton immediately in every case of carcinoma of the breast which comes for treatment, either surgical or radiation, and these examinations are then repeated at intervals. In certain instances, I make a clinical diagnosis of a beginning metastasis in the lungs by the appearance of an occasional slight dyspnea on exertion which the patient does not notice. If an immediate roentgenogram of the chest is negative the examination is repeated at frequent intervals. It may take three months and even more after the onset of dyspnea before the metastases become evident. It must be assumed that it takes even a longer time between the beginning of the development of a primary carcinoma of the lung and the appearance of clinical or roentgenologic manifestations. Thus, notwithstanding the improvements in diagnostic methods, practically all cases diagnosed as such are already in an advanced stage of the disease and frequently indicate the presence of metastases.

In order to improve the situation every patient of cancer age who comes with vague symptoms which indicate the possibility of malignancy without any clear evidence of a primary condition elsewhere should have a roentgen examination of the chest. Indeed this should be a routine procedure for every patient that is admitted to a cancer clinic.

SURGICAL TREATMENT

The rationale in the treatment of primary carcinoma of the lung again is analogous to the methods of treatment of carcinoma of the breast. In view of the fact that, in both conditions, metastases in distant organs develop early it is imperative that the primary tumor be removed as rapidly as possible and therefore *surgical treatment* is *a priori* the most efficient method. There are two methods of surgical approach conceivable in carcinoma of the lung, namely the removal of the tumor by the aid of a *bronchoscope* or by opening the thorax (thoracotomy). The first method is evidently inefficient since only the part of the tumor can be removed which is visualized in the bronchoscope and that means a partial removal of the tumor which is worse than useless in cancer therapy. By the second method of thoracotomy it is possible technically to remove the tumor in its entirety with the involved lobe of the lung or even the whole lung (*lobectomy* or *pulmonectomy*). At the same time metastatic lymph nodes in the mediastinum may be removed and even an involved part of the pleura with the subjacent ribs resected.

Thoracic surgery has made great progress in the last two decades and while the postoperative mortality is still very high, the method appears *a priori* quite promising and should become the method of choice. In actuality, however, little of practical value has been obtained to date by this method of treatment. Sauerbruch,[12] who is the originator of modern thoracic surgery, reported, in 1920, a case of primary carcinoma of the lung which survived the intrathoracic removal of the tumor for over a year, and another case in 1926 and since then and to date only 4 more cases

were reported throughout the world. The latest case of Graham and Singer[5] of a complete pulmonectomy was last reported in September, 1933, as having survived the operation for six months. Edwards lately reported on 3 more cases that survived for over a year.

The reason for the paucity of good results in surgical treatment of primary carcinoma of the lung is clearly demonstrated in the recent article of Rabin and Neuhof.[11] In this article a report is given of 250 cases of primary carcinoma of the lung. From the standpoint of operability the authors divided their cases into two groups. Group one comprises the tumors of the lung root zone and constitutes three-quarters of all the cases. They are tumors which develop in the main and branch bronchi, grow invasively and diffusely, and these belong to the inoperable cases. The second group consists of tumors of the parenchymal or peripheral part of the lung. They constitute one-quarter of all their cases, form circumscribed tumors or invade only the periphery, and this group they consider favorable for surgical treatment. Five of the 250 cases were operated upon. Only one of these cases lived over one year and then died of metastases. No statement is made whether any more cases of this group of 250 patients were operated upon. However, the ultimate results in the 5 cases reported were not favorable, so one must assume that if more patients were operated upon the results must have been poorer than in the cases reported.

Analysis of all the results obtained by surgical treatment of primary carcinoma of the lung indicates that in an ideally favorable case perfect results could be obtained, and it is therefore legitimate to continue to experiment with the method, notwithstanding the high operative mortality, since without treatment any patient with primary carcinoma of the lung is doomed. However, to date the number of cases which can be expected to be benefited by surgery alone is so small that it is imperative to look for other methods of treatment.

RADIATION TREATMENT

In the consideration of the rationale and value of radiation treatment in primary carcinoma of the lung, one is again impressed by the close analogy which exists between carcinoma of the lung and of the breast. It is much easier to obtain an early diagnosis in the breast than in the lung and still surgery alone succeeds in not more than 15 per cent of all cases of carcinoma of the breast, while superior results may be obtained by correct coördination of surgery and radiation treatment. Edwards,[3] in the article quoted above, states that of 40 patients who were submitted to a thoracotomy, radical surgical procedures were done in only 14 cases, while in 27 cases radon seeds were inserted into the tumor. It would seem to me that the surgical results would be much superior if instead of attempting to remove the tumor radically in every case submitted to operation, a better selection were made. If it is found that a complete radical operation cannot be done then radon capillaries should be inserted into the tumor, the thoracotomy wound closed and treatment continued by high voltage roentgen therapy and surface application of packs of radon. This is the combined technique which I advocated[8] and which has proved to be very efficient in carcinoma of the breast.

In not less than 75 per cent of all cases of primary carcinoma of the lung, however, a diagnostic clinical and roentgen analysis shows that any operative interference is useless. All these cases, in my opinion, should be submitted to roentgen therapy and surface application of radium, and when the pleura is involved an insertion of radon capillaries should be done through the chest wall. By these methods good palliative results with relief of symptoms and possibly prolongation of life may be obtained.

The only legitimate object in surgery of carcinoma of the lung is an attempt to produce a cure and it is not reasonable to subject a patient to a hazardous undertaking of a surgical removal of the tumor for palli-

Fig. 4. Case II. Roentgenogram of chest shows pleuritic effusion in the left side of chest and displacement of the heart to the right.

ation. Therefore surgery in metastatic carcinoma is entirely out of the question. Radiation treatment, on the other hand, to date attempts only to obtain palliative results since the method is generally employed in far-advanced cases. The technique employed and the results obtained are so nearly identical in primary and metastatic carcinoma of the lungs that the two conditions may be considered together. Particularly is this true of pulmonary metastases in carcinoma of the breast which, as stated above, may be detected comparatively early.

The following cases may serve to illustrate the technique used and the results obtained in both metastatic and primary carcinoma of the lung.

Case II. L. D., female, aged fifty-six, was examined on September 14, 1932, with a statement that in 1921 and 1923, two local excisions were done of a tumor of the right breast. At the second operation malignancy was diagnosed. The patient refused any treatment until the last consultation. At this time a large tumor was found in the right breast adherent to the skin. A large metastatic lymph node was found in the right axilla and secondary malignancy in the left breast. There were several metastatic nodules found in the skin surrounding the right breast. No other distant metastases were found. I did a double mastectomy with a wide excision of all the skin around the right breast containing metastatic nodules. Microscopical analysis showed adenocarcinoma. The operation was followed by roentgen and surface radium therapy. *Roentgen examination* immediately before the operation showed no evidence of any metastases nor any other pathology in the chest, with the exception of enlarged calcified lymph nodes in the right hilum region. No metastases nor other pathology were noted in the skeleton. The patient came for reëxamination on July 19, 1934, complaining of severe dyspnea. On clinical examination the right lung showed complete dullness on percussion and loss of vesicular breath sounds on auscultation, with the exception of the infraclavicular region where increased breath sounds were noted. On *roentgen examination* the right side of the chest showed clear aerated lung tissue. The apex, domes and costophrenic angles were clear. The heart was displaced to the right and partly covered the hilum. The calcified nodes described in 1932 showed through the density. The left lung showed a shadow of extreme density which obscured the ribs, mediastinum and diaphragm. In the region of the apex and to the level of the 4th rib the density was less

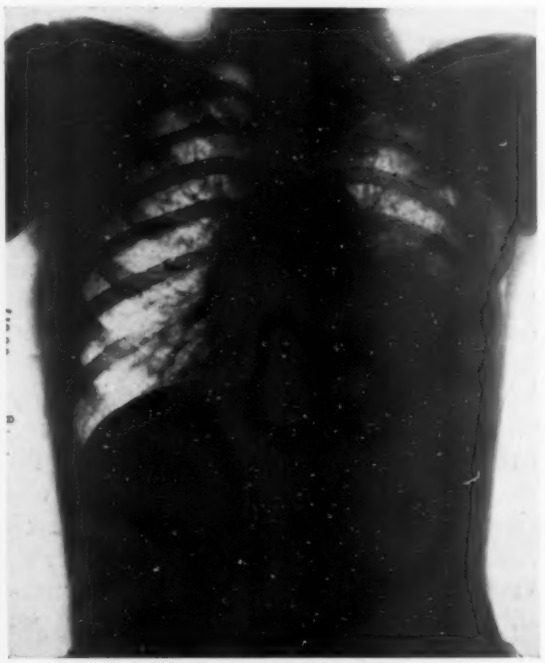

Fig. 5. Case II. Six months later roentgenogram shows heart in normal position, no fluid in the left pleura. Tumor present in lower lobe of the left lung and general thickening of the left pleura.

pronounced and the ribs and lung tissue could be seen hazily. A pleuritic effusion (Fig. 4) has evidently developed.

In view of the fact that the patient was a highly intelligent person and a thoracocentesis would have produced a severely depressing mental effect, I decided to continue with intensive radiation therapy without removing the fluid. The condition of the patient symptomatically gradually improved and roentgen examination on September 26, 1934, and again on January 18, 1935, showed the following condition: The right lung remained normal. The displacement of the heart to the right has disappeared. The upper half of the left lung to the 7th rib is entirely clear. There is an infiltration noted extending out from the left hilum to the pleura and down to the diaphragm. There is also present a general thickening of the pleura (Fig. 5). The patient remained fairly comfortable and lived fourteen months after the pulmonary condition was discovered.

Comment. This case is remarkable because, apparently, pleural effusion was absorbed by the aid of radiation treatment. The general condition improved and the patient lived for fourteen months longer, which is a very unusual length of time and must undoubtedly be ascribed to the radiation treatments.

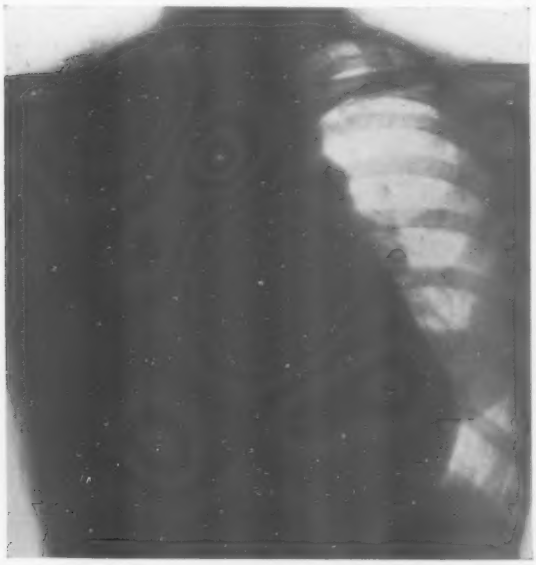

Fig. 6. Case III. Roentgenogram shows pleuritic effusion throughout the right side of the chest.

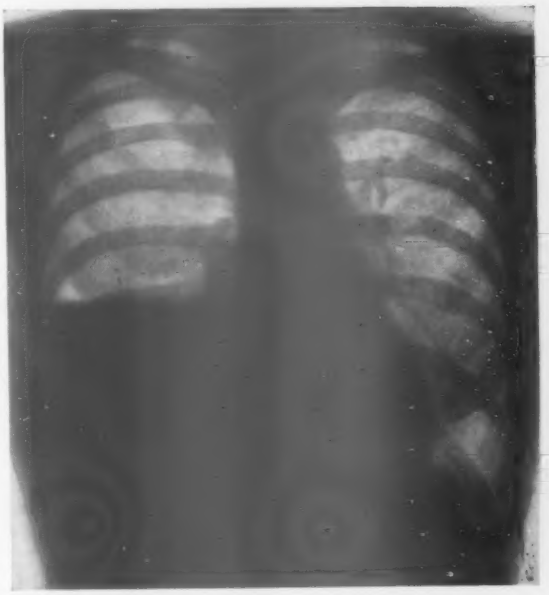

Fig. 7. Case III. Three and one-half months later. Roentgenogram shows the fluid level at the fourth right rib and pneumothorax above. Radon capillaries are visualized.

Case III. M. P., female, aged thirty-nine, was seen on March 5, 1930, with a history of having noticed a mass in the right breast eighteen months previously and an ulceration for the last six months. The patient also complained of dyspnea and cough. On examination the right breast was found transformed in its entirety into a flat hard and nodular tumor mass, firmly adherent to the chest wall. Surrounding and partly undermining the nipple there was a flat ulceration measuring about 8 cm. in diameter. A hard and nodular tumor was found in the axilla. On percussion of the chest the right side showed dullness everywhere and on auscultation total loss of breath sounds. *Roentgen analysis* of the chest on March 5, 1930, showed a pleural effusion throughout the right chest obliterating the domes of the diaphragm, the costophrenic sinus and right cardiac border (Fig. 6). A diagnosis of carcinoma of the breast with metastases to the pleura and lungs was made. On March 8, a thoracocentesis was done and 1,500 cc. of straw-colored fluid was obtained; then a specimen of tissue for a biopsy was taken from the ulcerated area, which confirmed the diagnosis, and radon capillaries were inserted into the tumor of the breast and of the axilla. This was followed by radiation treatment. On June 20, the thoracocentesis

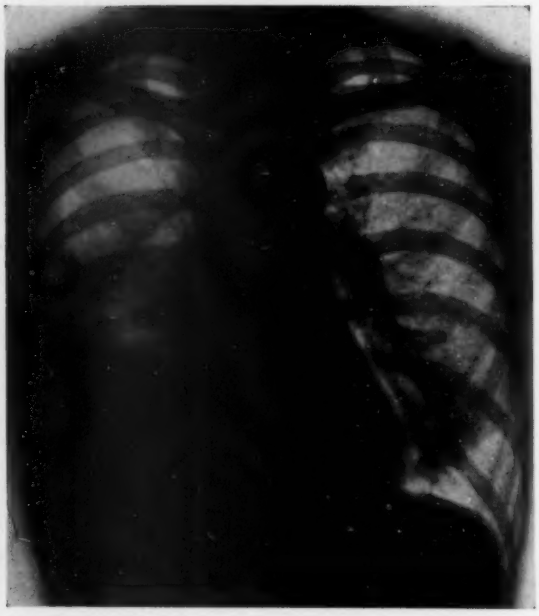

Fig. 8. Case III. Five months later. Roentgenogram shows the pneumothorax to have disappeared and the lung expanded.

and the radon insertion were repeated. *Roentgen analysis* of the chest on June 21, 1930, showed the upper level of the fluid at the 4th right rib anteriorly. The upper portion of the chest showed pneumothorax. The radon capillaries were visualized (Fig. 7). The radiation treatment was continued and no further thoracocentesis was necessary; the ulcerated area became covered with epidermis. *Roentgen analysis* on August 15, 1930, showed the pneumothorax to have disappeared and the lung to have expanded (Fig. 8). On March 17, 1931, *roentgen analysis* showed a further increase of the clear area of the right lung. Meanwhile neither the tumor of the breast nor the one in the axilla was palpable at the time. The patient lost her distressing symptoms of cough and dyspnea and felt clinically well until April, 1931, when suddenly symptoms of cerebral metastases developed and she died on April 16.

Comment. The therapeutic result of irradiation in this case was certainly remarkable, and had it not been for the cerebral metastasis which is comparatively infrequent in cancer of the breast, the patient's life might have been prolonged still further. It is probable that the insertion of radon capillaries into the tumor of the chest wall contributed considerably to the success in this case.

Case IV. Male, aged fifty-two. The patient was admitted to the hospital on August 19, 1935, with complaint of slight cough for the last two months. Four weeks ago he had a chill and his temperature rose to 105° F. and since then the patient has been running a high temperature up to 104° F. On clinical examination of the chest, no pathology was noted. On bronchoscopic examination, the bronchi of the right lung appeared normal. In the left lung, there was noted a whitish ovoid mass obstructing the left lower bronchus appearing to come from the postero-lateral branch. Slight purulent secretion was visualized behind the mass. A piece of tissue was taken for biopsy. *Microscopical analysis* of the tissue showed small groups of cells suggestive of a malignant tumor but no definite diagnosis could be made on account of an insufficient amount of tissue. *Roentgen examination* of the chest (Fig. 10) on August 20, 1935, showed the presence of an irregular pneumonic infiltration in the posterior portion of the left lower lobe. No fluid levels were demonstrated. There has been an old resection of the 9th rib in the posterior axillary line with regeneration of bone and bridging between the

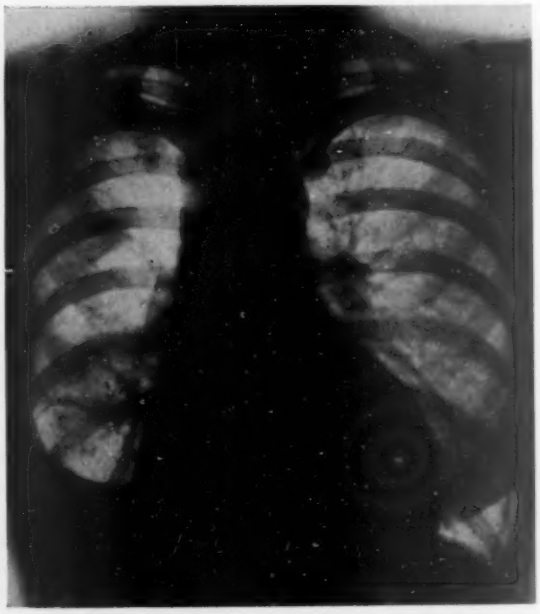

Fig. 9. Case III. One year later roentgenogram shows a further increase in the clear area of the right lung.

8th, 9th and 10th ribs of this side. There was also noted some thickening of the pleura of the right side. The patient continued running a septic temperature. Radiation treatment was instituted and on October 30 a *roentgen examination* of the chest showed a shadow of diffuse density indicating the presence of fluid and thickening of the wall of the pleura on the left side of the chest (Fig. 11). On November 2, 1935, a thoracocentesis was done and 1,000 cc. of serosanguineous fluid obtained. The radiation treatment was continued and at the same time blocks of radon were placed over the posterior wall of the chest corresponding to the base of the left lung. On November 18, 1935, again 1,000 cc. of serosanguineous fluid was aspirated by a thoracocentesis. Subsequent attempts at thoracocentesis failed to produce any fluid. Meanwhile the coughing had somewhat subsided, but the patient developed metastases in the liver and died on May 18, 1936, nine months since the beginning of the treatment. Autopsy showed a large tumor mass obstructing the left main bronchus just beyond the bifurcation. The tumor extends outward into the periphery of the lung. The bronchi are filled with purulent material. There is marked thickening of the pleura. About 200 cc. of fluid was found in the pleural cavity. The left lung is collapsed. The right lung is edematous and shows patches of bronchopneumonia. The liver is large and studded with metastatic nodules. No pathology found in the heart.

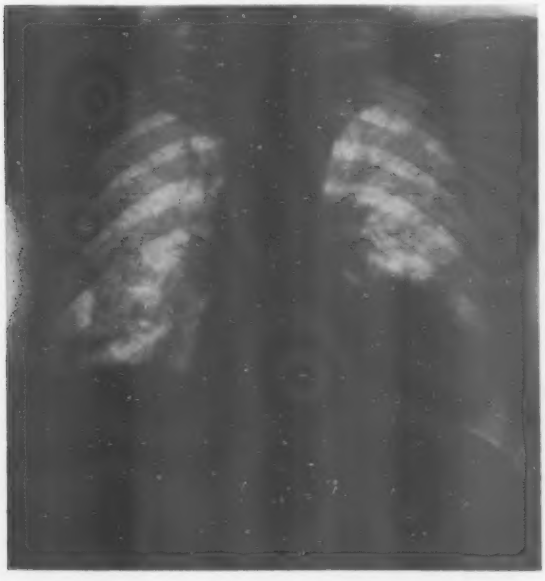

Fig. 10. Case iv. Roentgenogram shows an irregular pneumonic infiltration in the posterior portion of the left lower lobe.

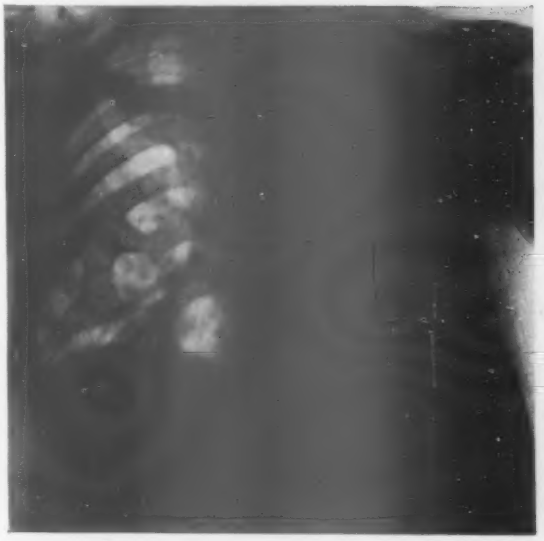

Fig. 11. Case iv. Two months later. Roentgenogram shows the presence of fluid and thickening of the wall of the left pleura.

Comment. This case presents many features of interest. In the first place, on admission the patient gave a history of only two months' duration and the symptom-complex was indefinite. The examination, however, revealed a very far-advanced case of carcinoma of the left bronchus. The next feature of great therapeutic value is the fact that at the beginning of the treatment thoracocentesis had to be done twice in a period of two weeks, which is usually the case in pulmonary carcinoma with involvement of the pleura. Thoracocentesis usually has to be done in two weeks, then once in ten days and later once a week. In this case, after two weeks of radiation treatment the accumulation of fluid in the pleura ceased. In this respect Case iv closely resembles Cases ii and iii.

Case v. D. S., male, aged fifty-three, came for examination on November 2, 1935, with a statement that four months previously he had an attack of severe pain in the chest at night which disappeared on the next day. Two weeks later he developed an acute pain in the right side of the chest and also in the right shoulder which did not subside. On *examination* the

Fig. 12. Case v. Roentgenogram shows an area of increased density in the middle of the lower lobe of the right lung.

Fig. 13. Case v. Roentgenogram shows the lateral view.

patient appeared to be a well-nourished individual and nothing abnormal was noted on inspection, on auscultation and percussion of the left side of the chest. The heart and left lung appeared normal. In the right lung, in the center of the right side, there was an area in which there was noted a slight dullness on percussion and no abnormality on auscultation. *Roentgen examination* of the chest (Figs. 12 and 13) showed an area of increased density, irregularly round in outline measuring about 6 cm. in diameter which is situated in the mid-

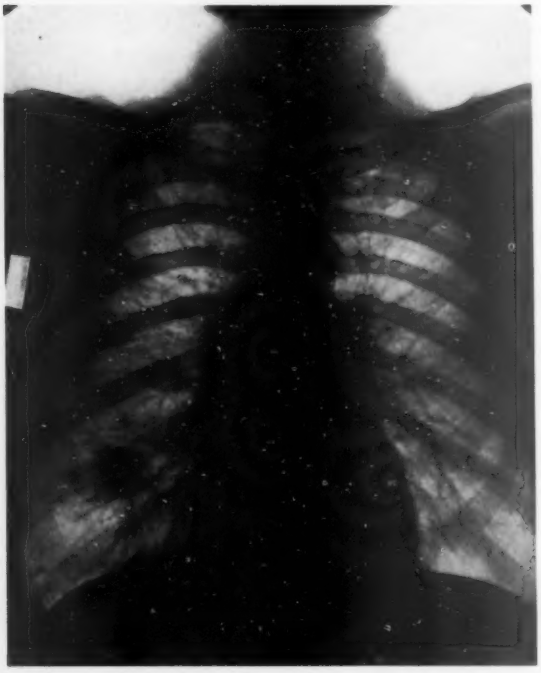

Fig. 14. Case v. Roentgenogram shows diminution in the size of the dense area in the right lung.

dle of the lower lobe of the lung. The hilum regions are normal and no pathology found elsewhere in the lungs. On abdominal examination no masses were found anywhere. Liver and spleen were not palpable. Rectal examination showed the presence of hemorrhoids, normal prostate and no other pathology. Diagnosis was made of *primary carcinoma in the parenchyma of the lung*. Since the tumor was at a great distance from the main and branch bronchi a bronchoscopy was not attempted. The patient refused any surgical intervention. The usual course of high voltage roentgen therapy was given and a pack of radon applied posteriorly, approximately at the level of the tumor. Seven weeks after the beginning of the

treatment, roentgen examination of the chest showed a distinct diminution in the size of the dense area (Fig. 14). At the same time the pain in the right shoulder and the chest completely subsided. In June, 1936, seven months after the first development of the disease, the patient began complaining of constant vomiting and occasional hemoptysis. On examination the patient appeared emaciated and cachectic. There was edema present in both lower extremities. On examination the chest clinically and roentgenologically showed no change since the end of December, 1935. No adenopathy was noted anywhere. On palpation of the abdomen the border of the liver was palpated 8 cm. below the free costal margin. It was firm in consistency. No other masses were palpated in the abdomen. A complete clinical and roentgen analysis of the gastrointestinal tract and all the genitourinary organs showed no evidence of the presence of malignancy anywhere else. The diagnosis was made of metastatic carcinoma of the liver. The patient at the same time complained of severe pain throughout the skeleton. Roentgen examination showed evidence of skeletal metastases. The patient died on January 10, 1937, about fifteen months after the beginning of the illness.

Comment. In this case surgical interference was refused by the patient when he first came for examination. However, seven months later, on examination, the liver appeared so much enlarged that there cannot be any doubt that small metastatic tumors must already have been present in the liver at the first examination. The diminution in the size of the primary tumor seven weeks after the beginning of radiation treatment shows distinctly that primary carcinoma of the lung may be influenced by irradiation.

SUMMARY AND CONCLUSIONS

A quarter of a century ago primary carcinoma of the lung was considered to be a rare disease. At the time, I had the opportunity to study the disease; all my material, however, consisted of far advanced cases and was interesting only from the standpoint of pathology. The diagnosis and clinical course, particularly in the early stage of the disease, were unknown.

The development of thoracic surgery, on the one hand, and of the latest methods of roentgen and radium therapy on the other, awakened a clinical interest in the subject and created a more urgent need of early diagnosis. Bronchoscopy and refinement in the methods of diagnostic roentgenology of the chest seemed to promise better diagnostic results. However, the disease in nearly half of the cases gives no symptoms referable to the lung, and even when the symptoms appear early, there are no organic lesions present which can be detected by any of our diagnostic methods. As a result, even today, as a general rule, primary carcinoma of the lung is met with only in its advanced stages.

Metastases in distant organs (liver, skeleton, brain) develop in a great percentage of cases and in the early stages of the disease. Therefore the primary tumor must be removed rapidly before metastases have developed and that means a radical surgical removal.

Carcinoma of the lung may be removed surgically by the aid of bronchoscopy or of thoracotomy. The latter offers the only efficient method for radical surgical removal.

Technically the methods of lobectomy and even pneumonectomy have greatly advanced, and in ideally selected cases complete eradication of the disease may take place. In actuality, however, good results were obtained in only a few scattered cases. One must keep in mind, however, that even in carcinoma of the breast, in which it is easier to obtain an early diagnosis, eradication of the disease by surgery alone succeeds in not more than 15 per cent all the cases. Surgery in carcinoma of the lung is much more hazardous and diagnosis much more difficult. Thus, with very rare exceptions, radiation treatment is the only method available for practically all cases of carcinoma of the lung.

The opinion that good therapeutic results cannot be expected from radiation treatment because carcinoma of the lung is radioresistant does not agree with the clinical results obtained. Radioresistance and

radiosensitivity are relative terms. The original small tumor may consist of highly differentiated and therefore radioresistant cells but as the tumor grows the new daughter cells become undifferentiated and therefore radiosensitive. Carcinoma of the upper air passages is as radioresistant as the carcinoma of the lung but, nevertheless, Coutard[2] obtained excellent results with roentgen therapy. One of the reasons is that in this region it is easy to apply a sufficient intensity of radiation to the tumor. My clinical and experimental investigations with Schwarzkopf[10] have shown that the necessary amount of radiation can be brought to the tumor with greater ease in the chest than in the pelvis. The results which I obtained in Case v show that the primary tumor in the lung can be promptly influenced by irradiation. The cessation of the accumulation of the pleuritic effusion in Cases II, III and IV is further proof of the efficiency of radiation treatment. I have shown in previous publications[6,7,9] that irradiation of cancer cells is followed by formation of connective tissue. In the pleura this connective tissue, on the one hand, replaces secreting cancer cells and, on the other hand, creates adhesions between the layers of the pleura. Thus far the results obtained by irradiation are only palliative since the cases treated are in advanced stage.

The problems for the future clinical research in carcinoma of the lung are to obtain an early diagnosis, particularly by the aid of repeated examinations and devise such coördination between surgery and radiation treatment that the latter may begin where the former left off and thus a combined total therapeutic result obtained. Even though to date, strikingly favorable results are obtained rarely by either surgery or radiation treatment or the combination of both, there is no need to despair of the future.

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DEPTH EFFECTS IN ROENTGENOGRAMS

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THE investigations described in this paper began several years ago in a desire to explain the following phenomena:

(1) A pair of stereoscopic films appeared to show more clearly the relative positions of small pieces of lead and neighboring vertebral bodies when viewed pseudoscopically than when viewed in the normal position;

(2) In pictures of a test object consisting of two parallel metal rings with a metal rod mounted in a parallel plane between them—used in demonstrating stereoscopic films to students—the rod sometimes appeared to pass through one of the rings;

(3) An account appeared in the AMERICAN JOURNAL OF ROENTGENOLOGY AND RADIUM THERAPY[1] describing repeated failure to locate correctly a bullet in a cervical vertebra by various means, including stereoscopic films.

In the first two cases the general stereoscopic effect appeared satisfactory on casual inspection, but further consideration suggested that in certain cases something other than a truly stereoscopic effect might influence the impression received. In the third case the films were not available for study, but conditions were similar in some respects to those of the first two cases, consequently the failure of the stereoscopic method emphasized the importance of the questions which had been raised.

These questions led to the study of certain factors which have a bearing on the interpretation of roentgenograms. These factors are not important in the general run of cases, in which diagnosis is unmistakable so far as depth effects are concerned, but in some instances they may become important. The object of this paper is to call attention to these factors, and to emphasize precautions which may help to reduce the small number of doubtful or incorrect interpretations.

DEPTH EFFECTS IN NATURE AND IN ORDINARY PICTURES

In viewing natural objects we receive impressions of depth—that is, of relative distances of different objects from us—by various means, including stereoscopic vision, perspective, parallax, the observation of shadows, and muscular effort. In ordinary flat pictures most of these effects can be simulated in the picture itself,[2] but, since the different parts of the picture are all in the same plane, we lose the aid of stereoscopic vision and muscular effort; in fact, stereoscopic vision is actually a disadvantage, since through it we know that all the objects depicted are at the same distance, namely, that of the plane of the picture. We can increase the illusion by closing one eye, but as a rule we simply ignore the stereoscopic effect when looking at a picture. Some of the factors which do tend to produce impressions of depth we shall describe in more detail, as they may have counterparts in roentgen films.

(1) *Railroad track perspective*, resulting from the presence of converging straight lines, is one of the most common factors in the production of an impression of depth. It depends on the fact that a given distance perpendicular to the line of sight subtends a smaller angle at the eye, and produces a shorter image on the retina, the farther away it is. Two lines which are actually the same distance apart appear to converge as they recede; conversely, two lines which actually converge in a picture appear to recede, as a rule, if the observer recognizes in them the outlines of an object whose sides are parallel, or more nearly so than the lines in question. Frequently other types of perspective are combined with this (see below), and the total impression produced by inclined lines depends on their surroundings. For example, the same pair of lines may represent the edges of a hori-

zontal sidewalk or the sides of a vertical ladder, depending on the spacing and directions of other lines.

(2) *Overlay*, or apparent blocking by one object of the light coming from another, is a very important factor. In looking at natural objects *A* and *B*, in general we know that *B* is in front of *A* if the light from *A* is cut off by *B*, but how can we tell? We know it positively when there is relative motion between the retinal images, and this relative motion may result either from actual movement of *A* or *B* or from a movement of the head (parallax effect). If, however, the images are stationary, other factors determine whether or not we "see" *B* in front of *A*. The most important of these is interruption of pattern.

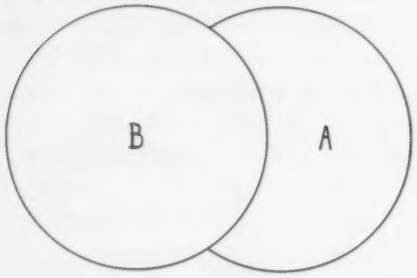

FIG. 1. *A* might represent a crescent in contact with a circle *B*, or a circle partly hidden by *B*.

In Figure 1 we cannot tell whether *A* and *B* represent a crescent and a disk in contact, or whether *A* would show a circular outline if *B* were not present. Something other than the mere outlines of the retinal image is needed, and this would be true even if *A* and *B* were thin disks of slightly different shades.

(3) *Interruption of pattern* is the most important factor in our judgment of overlay in the case of stationary images. If a glance out of the window results in two retinal images in juxtaposition, one that of a wall and the other that of half a horse, we are almost certain to "see" the wall as nearer than the horse rather than as sup-

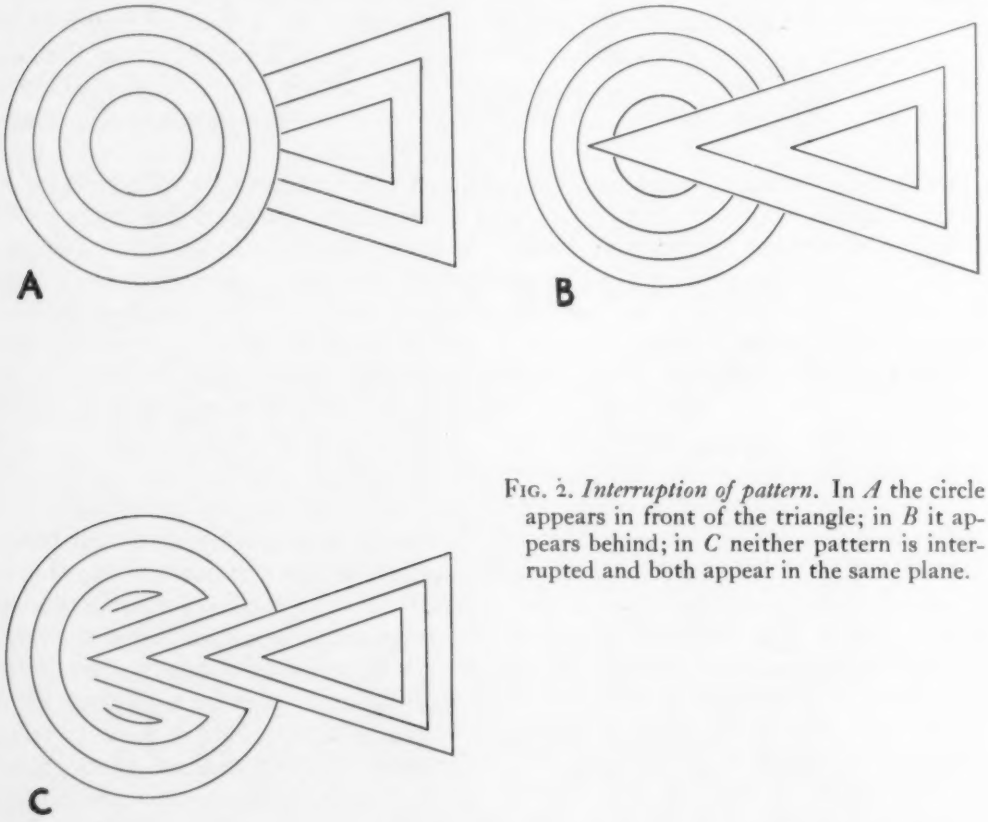

FIG. 2. *Interruption of pattern.* In *A* the circle appears in front of the triangle; in *B* it appears behind; in *C* neither pattern is interrupted and both appear in the same plane.

porting half a horse. Even without binocular vision, shadows or other aids, experience would lead us to this interpretation of interrupted pattern. Again, in Figure 2*A* the circle appears in front of the triangle, and in 2*B* the triangle appears in front of the circle, one pattern being complete and the other incomplete, while in 2*C* both types of pattern are complete and the whole figure appears in the same plane (to most people).

(4) *Definition*, or sharpness of outline, is another factor which suggests difference in distance. It is a common device of artists to draw with sharper outlines those objects which they wish to appear nearer, as in Figure 3.

(5) *Aerial perspective* depends upon the fact that contrast in light and shade, as well as in color, becomes weaker as distance becomes greater; therefore distance may be suggested in pictures by softening of contrast as distinguished from haziness of outline. Frequently, of course, these and other effects are used in combination.

(6) *Preconception* often plays a part in what we seem to see either in nature or in a picture. One illustration is the well-known "cubical" pattern, in which the observer can make a given set of corners look nearer or farther at will.

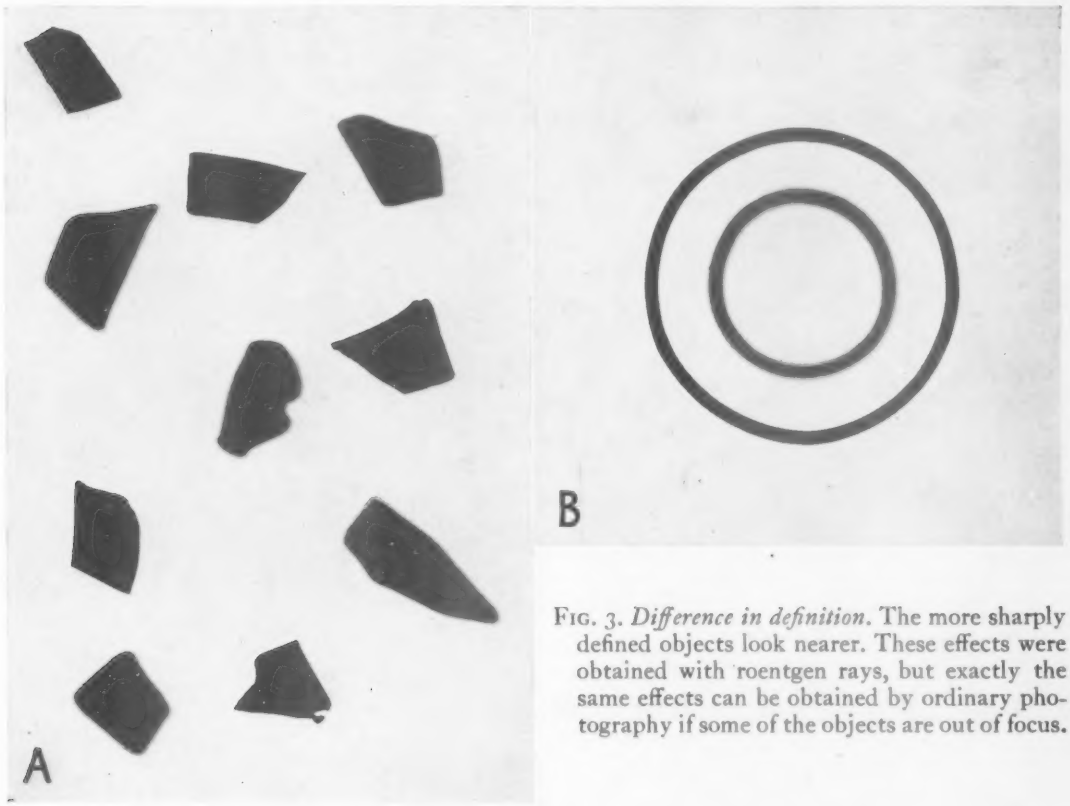

Fig. 3. *Difference in definition.* The more sharply defined objects look nearer. These effects were obtained with roentgen rays, but exactly the same effects can be obtained by ordinary photography if some of the objects are out of focus.

DEPTH IN SINGLE ROENTGENOGRAMS

Let us consider how the factors mentioned above may affect the interpretation of roentgenograms. In viewing a single film we judge the relative distances of objects largely by the definition of their shadows. Taking as our point of view the position of the tube, we know that the closer a given object is to the film, and therefore the farther it is from us, the sharper will be its shadow. We interpret the film in accordance with this knowledge, but the interpretation results from an intellectual process and is not what would be directly perceived by an un-

trained observer. This intellectual interpretation soon becomes habitual and replaces the type of perception which is common in viewing ordinary pictures. The elements on which such perception is based may, however, be present in roentgenograms, as will be shown.

Various depth effects in roentgen films are illustrated in Figures 3–8. These pictures should not be studied as for diagnosis, but just looked at briefly as ordinary pictures, with the expectation that in some cases different objects will seem to be at different distances. The effects are more noticeable if only one eye is used. All the effects referred to above are illustrated except that of preconception. They are essentially the same as in ordinary pictures, but the phenomena of overlay are more complicated because roentgen rays are much more penetrating than ordinary light.

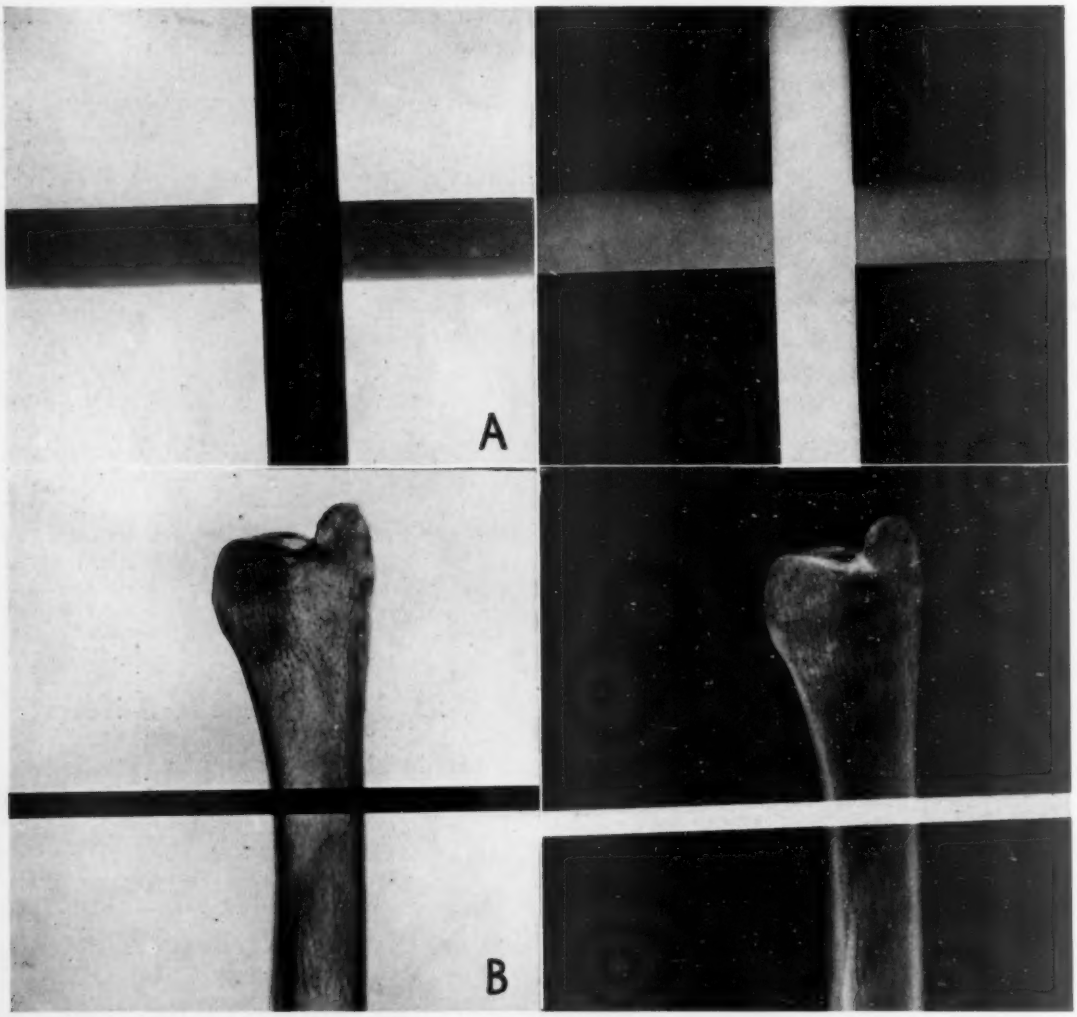

FIG. 4. *Complete blocking of rays by heavy metal.* The effect is the same whether we look at a negative or at a positive. *A*, lead strip (vertical) appears in front of tin strip; *B*, iron rod appears in front of bone although it was actually behind.

Roentgen rays which would give detail in the shadow of an object may be completely blocked by a very dense object *either in front of it or behind it* in the

beam, but the shadow of the dense object appears to be in front *in both cases* because of the complete interruption of the other's pattern (Fig. 4). When the shadows of two objects of nearly equal density overlap, details of both objects are present but are somewhat obscured. The one in which detail is less clearly marked in separate views is likely to suffer less change when the shadows are superposed, and therefore to appear in front of the other (Fig. 5). If

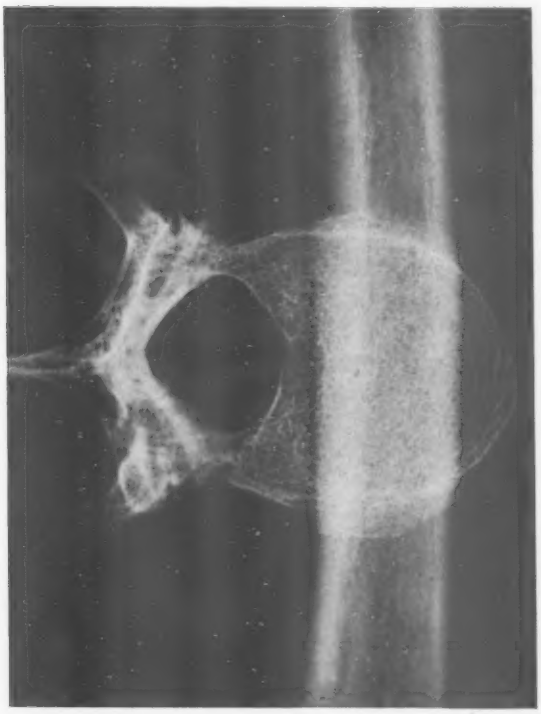

Fig. 5. *Partial blocking of rays by overlapping objects.* The long bone, with less detail, appears in front of the vertebra. (A trained roentgenologist says the long bone is in front because its shadow is less clearly defined, but a man who has never before seen a roentgenogram says the same thing just because it *looks that way* to him.)

one object has normally *no* detail within its outline, e.g., a thin sheet of metal, we have a rather special case; the result of superposition depends partly on interruption of its outlines, but may be different near the middle and near the edges of a comparatively large object.

Fig. 6. *Railroad track perspective*, combined with change of definition and contrast. "Tracks" extend back between two uprights.

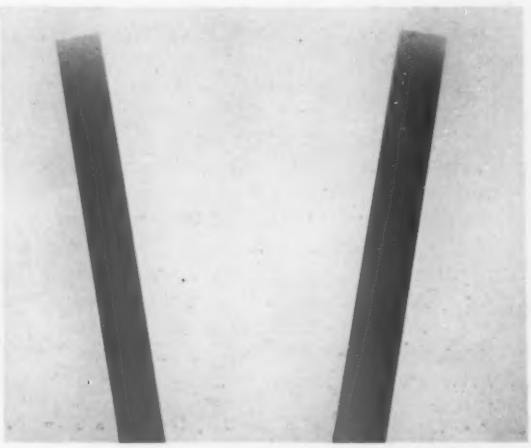

Fig. 7. *Change of contrast.* The upper ends seem farther back than the lower, though the definition does not change as in Figure 6. To some the tips appear to curl back.

Relation between stereo and single film effects

It seems clear that factors which give rise to impressions of depth in ordinary pictures are sometimes present in roentgen films. In the case of single films these factors probably are not often significant for the trained observer, since he is aware that he is studying the projection of three dimensional objects upon a plane; he is interpreting a diagram rather than looking at a picture. Even here, however, it is possible that he may be influenced by these

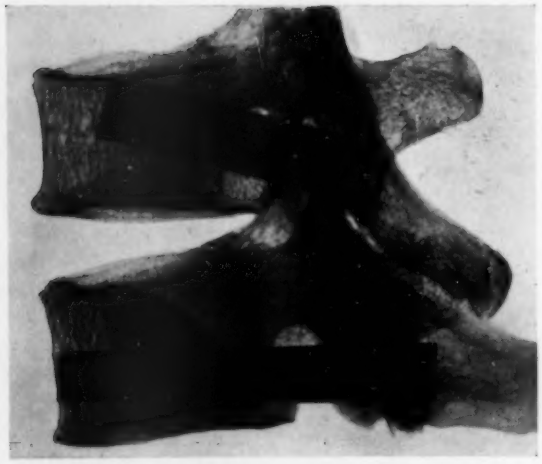

Fig. 8. *Overlay more effective than sharp definition.* The lead "bullet" appears in front of the lower strip of tin even though the tin is much more sharply defined; both strips of tin appear in front of the bones.

Note also the distorted appearance of the upper vertebra. The nearer side of the body seems shorter and both articular surfaces directly visible, because the heavy curved line which passes through the upper corner of the tin seems nearer than the other lines, as if it were the front edge of the upper surface. In reality it represents the back edge, and the body is quite symmetrical. The same effect is somewhat less marked in the lower vertebra. This appearance persists even in the stereoscopic view unless conditions are very good for stereoscopic observation.

factors in just those doubtful cases in which their influence might be most harmful. When we come to stereoscopic films the conditions are quite different, for in this case the observer has a definite expectation of perceiving directly—not deducing intellectually—the space relationships of objects. Under these conditions he is much more likely to be deceived by spurious depth effects.

If conditions are favorable for stereoscopic vision, the stereoscopic factor usually predominates over any other which may oppose it, for persons of normal vision. It depends more definitely on geometrical conditions and can be made the basis of quantitative comparison (for example, with the transverse dimensions of an object), while the other effects are qualitative and generally do not seem to lift one object much above another. If, however, for any reason conditions are *un*favorable for stereoscopic vision, other factors become relatively more important and they may predominate. What are some of these conditions?

(1) *Failure to Shift.* We cannot be sure that the operator will never forget, nor that the automatic machine will always work, so once in a while the films will be "identical." Usually this means that the expected depth effect is absent or very slight and the roentgenograms are retaken; but if some other factor is present which tends to make one object seem definitely in front of another in the separate films, this relation may be perceived and attributed to stereoscopic vision, particularly if the total depth of the object is not great (Fig. 9). The fact that this effect is present for each of the two eyes, separately, intensifies the impression. If the two films are not quite identical, so that a slight general effect of depth is produced in the rest of the picture, the impression may be still stronger.

STEREOSCOPIC PICTURES, FIGURES 9–19

The descriptions refer to what is seen by direct stereoscopic observation, the left film seen by the right eye and vice versa. If a prism stereoscope is used, the effects will in general be reversed except for Figure 9, which will remain as described. The directions of tilt in Figures 16 and 17 will be interchanged, as will the depth effects in Figures 10 and 13. The point illustrated will still be apparent except in Figures 11 and 12 and possibly in Figures 18 and 19.

Note on Observation without Stereoscopic Devices. The following method should enable one to obtain stereoscopic effects with a few minutes' practice when the pictures are small and close together. Some experimenting may be necessary in order to find just the right distances to use.

Hold the pictures at arm's length and bring up a pencil at about three-fifths this distance. Keep your eyes fixed on the end of the pencil as you bring it up, in line with the space between the pictures, and when it reaches the level of the bottom of the two pictures you will see a third picture—the stereoscopic image—nearly above the pencil. Keep the gaze fixed on this image and change the distance somewhat if necessary to bring the image into good focus. Figure 16 is best for practice.

(2) *Horizontal Lines Across the Field.*

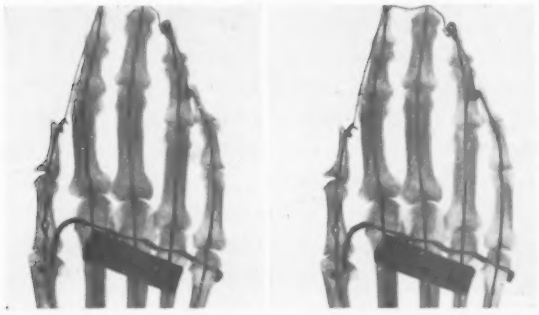

Fig. 9. *Failure to shift the tube.* This does not entirely eliminate the impression of depth in the joints nor the slight convexity of this dry hand seen from the back; nevertheless, all the metal looks closer than the bones, though the hand is resting on the large piece and the wires are inside the bones.

Stereoscopic vision depends on the relative disparity of images in the two eyes, in a direction parallel to that between the eyes, normally horizontal. If straight lines go entirely across the field of view in this direction, shifting lengthwise makes no difference in the images and no stereoscopic effect results. If some other factor which gives a pronounced depth effect is present, the case reduces to that above except that the chance for error is now greater because the films show real stereoscopic depth everywhere else (Fig. 10). This case is not likely to occur in practice unless the field is unduly limited, but the effect may be present even when the horizontal object does not go *entirely* across the field, especially if the attention is directed to a central point of interest (Fig. 11).

Fig. 10. *Straight lines across the field.* The horizontal strip appears closer than the hand, in spite of decided stereoscopic depth. Posterior view of left hand, resting on two metal strips.

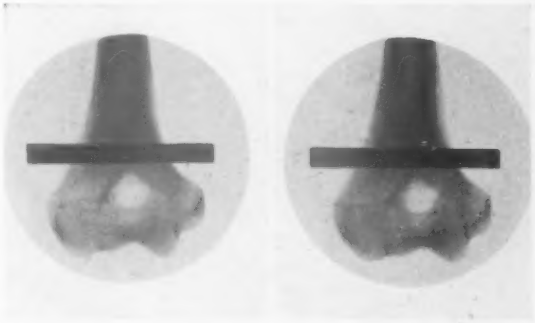

Fig. 11. *Straight lines partly across the field.* Normal stereoscopic depth in humerus. Bar which is behind appears in front.

(3) *Absence of Detail.* When there is very little detail in an object, especially if the object is relatively large or the attention is on a restricted area, the stereoscopic effect is less dominant. This condition is not infrequent in dealing with pieces of heavy metal, flat bones, and soft tissue, and with objects which are at some distance from the film.

(4) *Imperfect Register.* If the two films are nearly but not quite in register, fusion of the images generally takes place, but the resulting depth perception may be incorrect. For example, a slight relative rotation of the films in their own planes (see below), or the presence of a recurring pattern (Fig. 12), may give surprisingly incorrect effects.

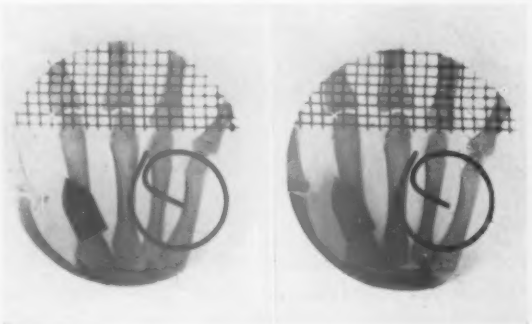

Fig. 12. *Effect of changing convergence.* Left hand, palm side. Two metal objects appear behind; if the small x marks near one edge of the netting coincide, the netting appears in front of the hand, but if the dots near the other edge coincide the netting appears behind. The second condition is correct—all the metal behind—but the first is much easier to establish.

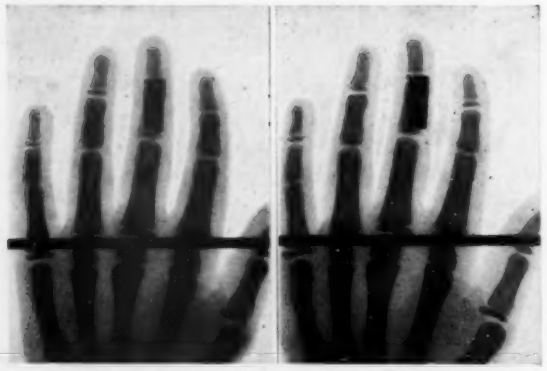

FIG. 13. *Pseudoscopic view of Figure 10.* The positions of the hand and the upper piece of metal seem reversed when the films are interchanged, but the bar still appears in front.

If the right and left films are interchanged (Figs. 10 and 13), the resulting pseudoscopic view should reverse the apparent order of objects in respect of distance; if it does not, then the predominating effect is not stereoscopic. The use of this position therefore provides a convenient check on relative distances as perceived with films in the normal position. Furthermore, an effect which opposes the stereoscopic in the normal position tends to reënforce it in the pseudoscopic, so that sometimes the correct order is clearer in this position than in the normal. (This is probably the explanation of the first case mentioned in the introduction, since the films showed overlay due to pieces of heavy metal.) Under these conditions the non-stereoscopic effect aids in bringing out the object which should appear in front, but since this effect is chiefly qualitative, any quantitative estimate of the distance is presumably controlled by the stereoscopic effect. It should be noted that relative *sizes* may be seriously altered in pseudoscopic images, but as a check on the order of objects in respect of *distance* this position is very useful.

EFFECTS DUE TO ROTATING STEREOSCOPIC FILMS

If one film is rotated slightly in its own plane in the viewbox, vertical lines in the two films become slightly divergent, but they can be fused practically as easily as before. The result is that a line which before appeared vertical in space now appears tipped to one side and forward or backward; if both films are rotated equally in opposite directions, the apparent tipping is forward or backward in the median plane. If the films are rotated a few degrees so that the tops of the images before fusion are tipped away from each other, the image of the vertical rod appears tipped straight forward through a much greater angle, as is shown by the curves of Figure 14. The result of changing the viewing distance is shown in Figure 15. The tipping effect increases rapidly, for any given amount of rotation, as the viewing distance is increased.

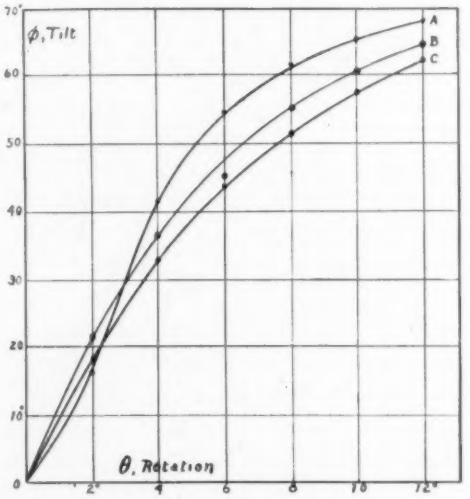

FIG. 14. *Tilt in the median plane as a function of rotation.* For theta = 2°, each film was rotated in its own plane 1° from its normal position. *A*, *B*, and *C* represent results of single series of readings respectively for various test objects, each including a vertical bar. Similar results were obtained by several observers.

The apparent angle in the median plane was determined for these films by setting a stick behind the viewbox mirrors at a distance approximately equal to that of the stereoscopic image of the rod, and rotating the stick about a horizontal axis until it appeared to be parallel to the rod seen in the mirrors. It was not difficult to compare

the slant of the rod seen in small mirrors with that of the stick seen over the mirrors, and the method was tested by taking stereoscopic films of the rod inclined at known angles and setting the stick parallel to the stereoscopic image when the films were in their normal position.

An explanation of the effects of rotation may be found in the relation between retinal images in binocular vision. A vertical series of points in an object is represented by a vertical series of points on each film, giving normally a vertical series of image points on each retina. (Vertical here refers to position as seen in the usual large stereoscope, considering the line between the eyes as horizontal; the relative positions of target and films in taking the pictures is the same as those of eyes and films in viewing them, whatever the actual position of the films may be.) If the point of fixation *A* lies on this line, the whole line is seen singly, for normal vision, since the two retinal images of any point on the line fall on corresponding points of the retinas, and the line appears vertical, at a distance appropriate to the amount of convergence,

If the two films slide horizontally in opposite directions, the convergence changes but the images still fall on corresponding

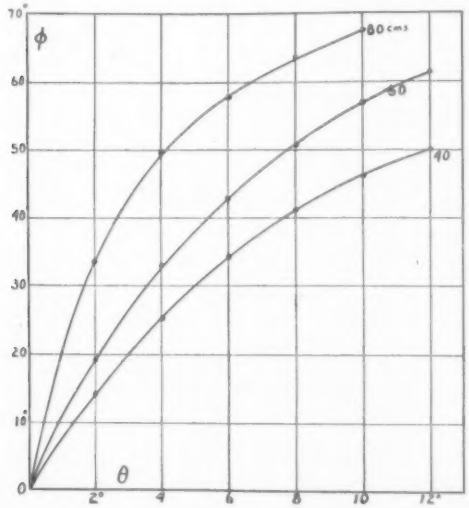

Fig. 15. *Angle of tilt as a function of viewing distance.* The films were taken at 60 cm. The curves show the apparent tilt for the same films at different viewing distances.

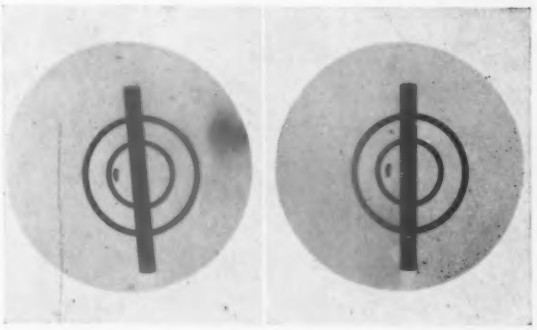

Fig. 16. *Effect of rotation with normal shift.* Bar appears tilted sharply forward at the top. True stereoscopic effect is seen in the lead chip, which is actually in front of the rings a distance about equal to the radius of the inner ring. The bar lies flat against the rings.

points, consequently the line is still seen singly but at a different distance. If, however, the films are rotated in opposite directions in their own planes, about the respective points representing *A* on the films, then the lines on the two retinas rotate in opposite directions, and, except for *A*, the images of a given object point no longer fall on corresponding retinal points. This difference in position of the two images of one object point increases uniformly as the lines diverge. The stereoscopic interpretation is that successive object points are at uniformly increasing (or decreasing) distances from the observer, consequently the original vertical line seems to acquire a uniform slant in the median plane. If the line does not pass through the point of fixation, rotation of the films produces the same kind of slanting appearance, superposed upon the ordinary stereoscopic space effects.

If the shadows are those of a ring, and rotation takes place about the centers, the images on the retinas are unchanged, consequently the plane of the ring remains unchanged. If then we have a ring and a rod in parallel vertical planes, relative rotation of the films causes tipping of the rod only, and may give the impression that the rod is sticking through the ring. This corresponds to Case 2 of the introduction, and is illustrated in Figure 16.

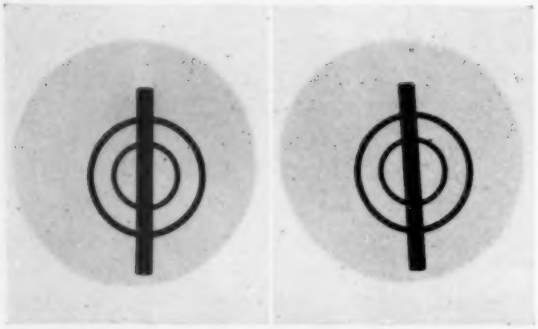

Fig. 17. *Effect of rotation, with no shift.* Rotation opposite to that of Figure 16 produces the opposite tilt, the bar apparently passing through the rings in the opposite direction. Entire effect due to rotation of identical films. Same object as in Figure 16.

The case mentioned showed also that a significant amount of rotation might be introduced unwittingly under practical conditions. The films were taken with ordinary care in placing the holders in the changing tunnel, but no markers were used and appreciable rotation of the films in the cardboard holders was possible. Experiment showed that 5″×7″ films could be rotated some 4 or 5 degrees relative to each other in ordinary cardboard holders, producing apparent tipping of about 30 degrees. With larger films the possible rotation would be less, but might be appreciable, in addition to what might occur in

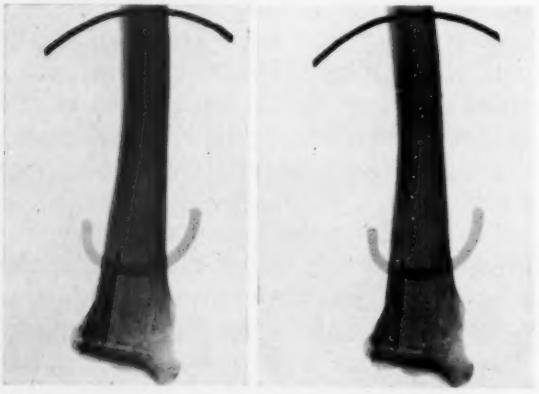

Fig. 18. *Rotation and overlay.* The brass wire at the top appears to curve round in front of the bone, and the aluminum to curve round behind it. Actually, the two were in planes nearly parallel to the bone, with the brass behind and the aluminum in front.

placing the holders in the plate changing device. Figures 16–19 are stereoscopic pairs illustrating effects of relative rotation, sometimes combined with overlay.

For lines parallel to the line between the eyes (horizontal) such effects of rotation are not observed. Image shifts in planes perpendicular to this line produce no stereoscopic effects, and consequently nothing which corresponds to tipping in the median plane. If more than a very slight rotation occurs, the observer is warned by clear double images that the

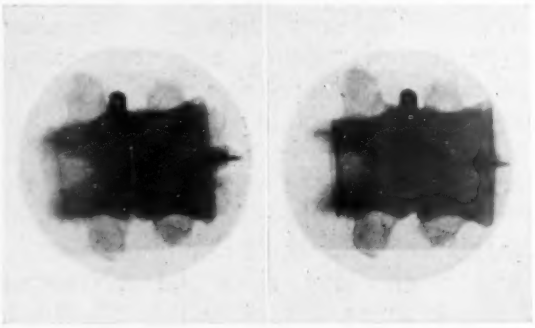

Fig. 19. *Rotation and overlay.* The lead slug appears to lie in front of the right hand edge of one vertebral body, as well as the intervertebral space, almost at right angles to the line of sight (that is, parallel to the plane of the film). Actually, it lay between the vertebrae, slanting away at an angle of about 30°, with only the nearer end projecting above the bodies.

films are not in register. For lines 2 inches long, a degree or two is sufficient.

The most effective precaution against errors of this kind is simply to use proper markers at the edges of the film changing tunnel, and to make use of them regularly when adjusting films in the stereoscope. A pair of dots, one on each side, produced by bits of heavy metal in the aluminum cover, is enough. A viewbox which can be rotated a few degrees about an axis perpendicular to the plane of the film is desirable, but the adjustment can be made by using a movable bottom in the film slot, with screws to alter inclination as well as height.[3] It is well to form the habit of observing lines which are nearly horizontal to see if they are in register even

though they are not close to the center of interest. If any straight edge on the film changer shows on both films it may be useful in adjustment, but the edges of curtains in the viewbox furnish no guide at all. The use of markers is particularly important in case a circular diaphragm is used in taking the films, since rotation about the center of its image on the film produces no change in its image and does not attract attention.

Any marked difference in the eyes of a given individual is likely to interfere with true stereoscopic vision, making it possible for non-stereoscopic and perhaps misleading depth effects to predominate, of the types shown in the first part of this paper. Also, rotational effects somewhat similar to those described may result from inequality of size or shape of ocular images in the two eyes, a defect which is not uncommon, as investigations by the Department of Physiological Optics in the Dartmouth Medical School have shown.[4] The obvious precautions in the case of individual observers are to try them with test films of known objects, and to compare their observations with those of other observers whose stereoscopic vision is known to be reliable under normal circumstances.

SUMMARY

It has been shown that certain factors which produce impressions of depth in nature and in ordinary pictures are present in roentgen films, and tend to produce the same effects; that these factors are not likely to be of importance for trained observers in viewing single roentgen films but may become important in stereoscopic films; and that distortion of large magnitude can be introduced by comparatively small rotations of stereoscopic films.

Attention has been called to the use of the pseudoscopic view as a check, especially for cases involving pieces of heavy metal or strong lines parallel to the direction of shift; and emphasis has been placed upon the importance of exact registration in minimizing effects due to relative rotation of films.

As a rule, true stereoscopic depth effects predominate over other depth effects under conditions favorable for stereoscopic observation, but it has been shown that spurious effects predominate under conditions which can be realized in practice.

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ENTERIC COATINGS

CLINICAL INVESTIGATIONS

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KALAMAZOO, MICHIGAN

IN TWO recent papers,[1,2] it has been shown how the effectiveness of an enteric coating may be studied in the laboratory. While such laboratory procedures are very useful in a broad way, clinical experience has shown that they are not necessarily an accurate gauge for the behavior of the coating in the human gastrointestinal tract.

The final and conclusive proof of the effectiveness of an enteric coating must be determined by the use of roentgenography and roentgenoscopy. By this means it is possible to actually visualize the progress of an enteric coated tablet or capsule as it passes down the intestinal tract until it disintegrates.

EXPERIMENTAL

One hundred and sixteen individuals ranging from eighteen to thirty years of age have been examined roentgenologically. Each subject swallowed three† enteric coated barium sulphate tablets or capsules** and the course of these was followed by roentgenoscopy at frequent intervals. When a significant change occurred, a roentgenogram was taken. Several representative clinical cases from the many studied are herewith described.

FIG. 1*a*

FIG. 1*b*

CASE 83. M. B., aged twenty-two. Normal gastric acidity. Breakfast: Bran flakes, tomato juice, orange, toast, coffee. The three tablets were taken following breakfast at 7:30 A.M. Figure 1*a* was made at 8:10 A.M. and shows the three tablets intact within the stomach.

* Deceased.

[1] Wruble, M. Enteric coatings. I. Laboratory method for study and control of enteric coatings. *J. Am. Pharm. Ass.*, 1935, *24*, 570.

[2] Wruble, M. Enteric coatings. II. Excretion studies with sodium salicylate tablets. *J. Am. Pharm. Ass.*, 1935, *24*, 1074.

† In a few cases the subjects swallowed four smaller tablets. One such case is included at the end of this report.

** These tablets and capsules were supplied by the Research Department of The Upjohn Company, Kalamazoo, Michigan.

Fig. 1*c*

Fig. 1*d*

The patient was roentgenoscoped at frequent intervals and Figure 1*b*, made at 10:15 A.M., shows two tablets in the stomach and one in the small intestine. Frequent roentgenoscopy showed no significant change until 1:20 P.M., when Figure 1*c* was made indicating two tablets in the first portion of the small intestine, one showing beginning disintegration. The third tablet has already disintegrated. Figure 1*d*, made at 1:50 P.M., shows all three tablets disintegrated in the first portion of the small intestine.

Case 74. J. I., aged twenty-two. High normal gastric acidity. Breakfast: Tomato juice, corn flakes, bananas, toast, cake. Three tablets

Fig. 2*a*

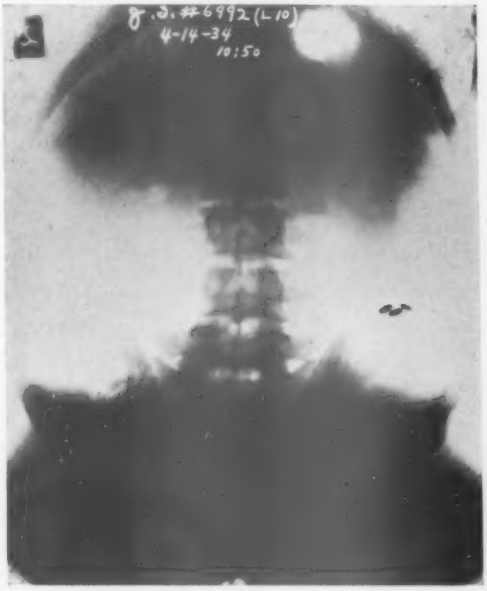

Fig. 2*b*

Fig. 2c

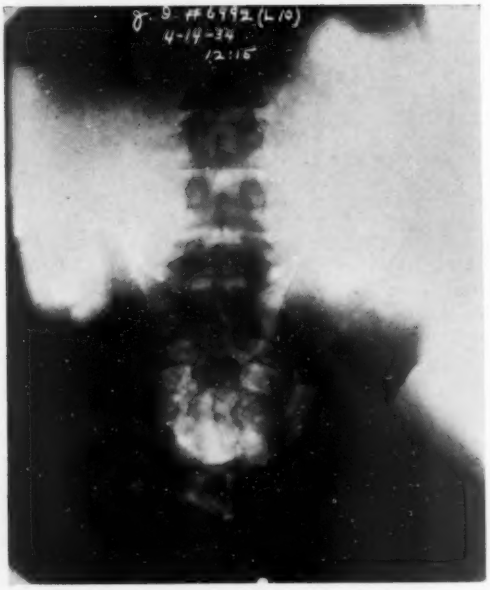

Fig. 2d

were taken following breakfast at 7:30 A.M. Figure 2*a*, made at 8:50 A.M., shows the three tablets intact within the stomach. The patient was observed under the roentgenoscope at frequent intervals until 10:50 A.M. when Figure 2*b* was made, showing the three tablets intact in the small intestine. A later roentgenogram (Fig. 2*c*) taken at 11:30 A.M. shows the three tablets still intact in the small intestine. The final roentgenogram (Fig. 2*d*) taken at 12:15 A.M. shows all tablets disintegrated in the small intestine.

Case 75. W. M., aged twenty-two. Normal gastric acidity. Breakfast: Tomato juice, pineapple juice, cocoa, toast, orange. The three

Fig. 3a

Fig. 3b

tablets were taken following breakfast at 7:30 A.M. Figure 3*a*, made at 8:10 A.M., shows the three tablets intact within the stomach. The patient was roentgenoscoped at frequent intervals and when Figure 3*b* was made at 11:45 A.M. the tablets were found intact within the first portion of the small intestines. Figure 3*c*, made at 1:10 P.M., shows the three tablets disintegrated within the small intestine.

Case 98. S. K., aged nineteen. Hypoacidity. Breakfast: Rice krispies, tomato juice, orange, cake. The patient took three capsules at 8:00 A.M. Figure 4*a*, made at 8:45 A.M., shows the three capsules intact within the stomach. The patient was examined by roentgenoscopy at frequent intervals until 10:00 A.M. when Figure 4*b* was made which shows the three capsules intact in the small intestine. Figure 4*c*, made at 10:40 A.M., shows the three capsules in the small intestine. One of these is intact, one has disintegrated and the third has begun to disintegrate. The final film (Fig. 4*d*) made at 11:15 A.M. shows that all the capsules have disintegrated.

Case 95. W. McC., aged nineteen. High normal acidity. Breakfast: Oatmeal, toast, coffee, grape juice. The patient took three capsules following breakfast at 8:10 A.M. Figure 5*a*, made at 8:45 A.M., shows the three capsules intact within the stomach. The patient was

Fig. 3*c*

roentgenoscoped at frequent intervals and Figure 5*b*, made at 10:40 A.M., shows the three capsules intact in the small intestine. A final roentgenogram (Fig. 5*c*) taken at 11:40 A.M. shows that the three capsules have disintegrated in the small intestine.

Case 88. C. C., aged twenty. Low normal

Fig. 4*a*

Fig. 4*b*

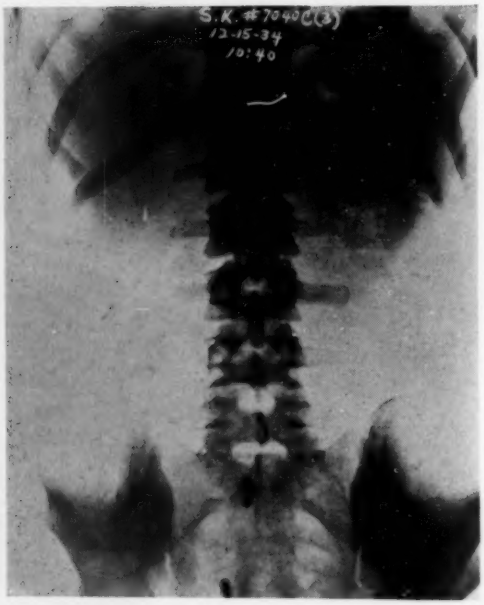

Fig. 4*c*

Fig. 4*d*

acidity. Breakfast: Shredded wheat, cream, egg, toast, coffee. For comparison, uncoated capsules of barium sulphate were administered. The patient swallowed the three capsules at 8:05 A.M., and upon roentgenoscopic examination at 9:00 A.M. it was observed that the capsules had disintegrated in the stomach. Figure 6 was taken at that time.

Case 6. R. S., aged twenty-four. Normal acidity. Breakfast: Glass of milk, two slices of toast, glass of water. The patient swallowed three tablets following breakfast at 7:30 A.M. Figure 7*a* made at 8:15 A.M., shows the three tablets intact within the stomach. The patient was observed at frequent intervals and Figure 7*b*, made at 5:00 P.M., shows that the tablets

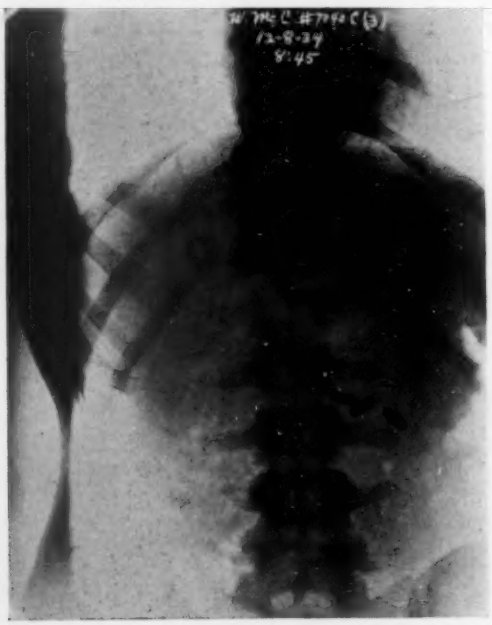

Fig. 5*a*

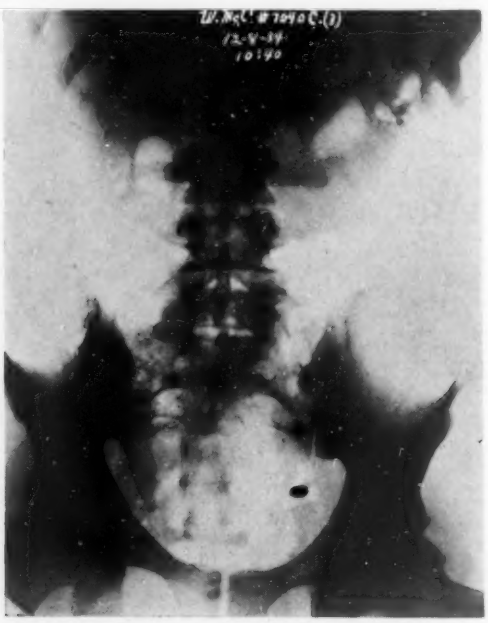

Fig. 5*b*

Fig. 5c

Fig. 6

are still intact within the stomach after nine and one-half hours' contact.

Case 45. E. S., aged nineteen. Hypoacidity. Breakfast: Orange, dry cereal, coffee, grape juice. The tablets were taken following breakfast at 7:30 A.M. Figure 8*a*, made at 8:05 A.M., shows all three tablets intact within the stomach. The patient was observed under the roentgenoscope at frequent intervals during the day. The tablets did not leave the stomach. Figure 8*b*, made at 5:00 P.M., shows all three

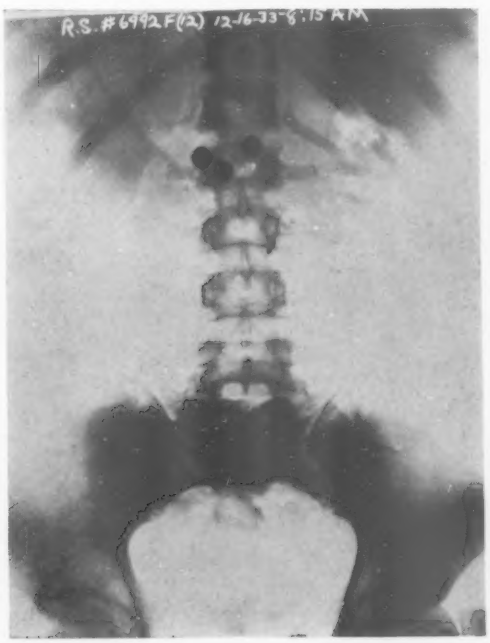

Fig. 7*a*

Fig. 7*b*

FIG. 8*a*

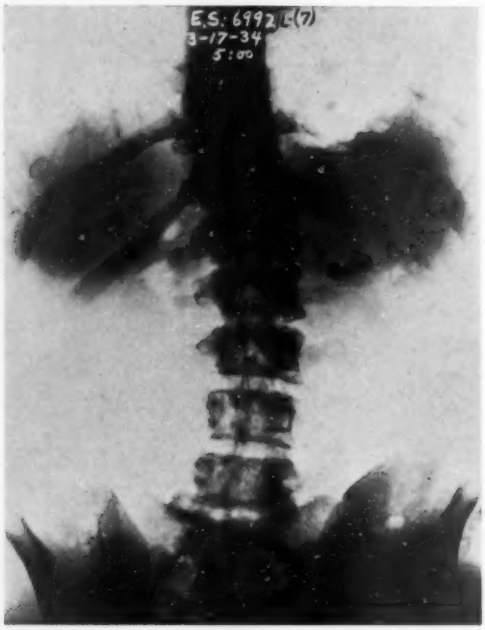

FIG. 8*b*

tablets intact within the stomach. It will be observed that disintegration did not commence although the tablets remained in the stomach for a period of nine and one-half hours.

CASE 63. H. S., aged twenty. Normal acidity. Breakfast: Bran, toast, egg, milk. The four tablets were taken following breakfast at 7:30 A.M. Figure 9*a*, made at 8:20 A.M., shows all tablets intact within the stomach. The patient was observed frequently by roentgenoscopy. The tablets had not left the stomach at 4:50 P.M., where they may be seen in the roentgenogram (Fig. 9*b*), two overlapping. These tablets had remained intact in the stomach for more than nine hours.

FIG. 9*a*

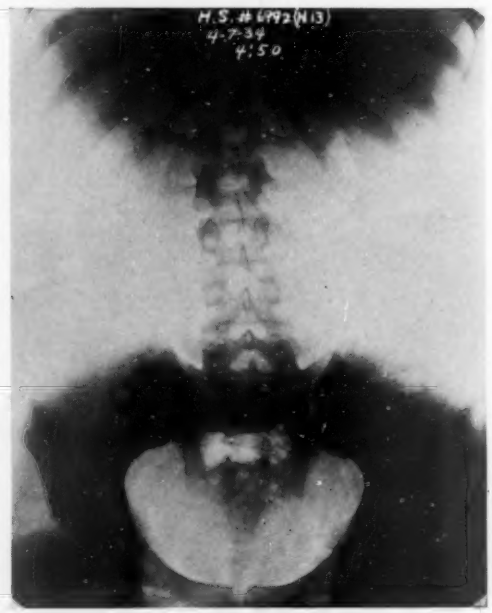

FIG. 9*b*

DISCUSSION

The wide variability in the gastrointestinal character of several individuals and even in the same individual at different times introduces great difficulty in the development of a suitable enteric coating. However, the average results of this comprehensive investigation, involving approximately 1,000 roentgenographic and roentgenoscopic observations,* indicate a passage through the stomach intact, and subsequent disintegration in the small intestine, of at least 85 per cent of the tablets or capsules swallowed. Approximately 15 per cent of these remained intact within the stomach for a period of nine to ten hours. It was not convenient to follow these tablets any longer by roentgen examination. No doubt many would have remained intact for much longer periods.

With a group of 54 individuals involving the disintegration of 162 enteric coated barium sulphate tablets selected at random, 18 remained intact in the stomach for nine hours or more. Of the corrected series of 144 tablets, 131, or 91 per cent, passed through the stomach intact and 126 of these, or 96 per cent, disintegrated in the small intestine. Only 5 entered the colon intact and not one was recovered in the feces.

* Roentgenographic and roentgenoscopic studies on this coating at the end of a year showed practically no change in its enteric properties.

CONCLUSIONS

(1) Enough clinical and laboratory evidence has been submitted to indicate that a new type of enteric coating has been developed which meets the most rigid requirements in chemical and physical properties, physiological inertness and clinical reliability.

(2) It is interesting to note that capsules leave the stomach much more rapidly than tablets.

Acknowledgment is made to Drs. J. B. Jackson and William A. Murray, of Kalamazoo, for their cooperation in this work.

THE AMERICAN JOURNAL OF ROENTGENOLOGY AND RADIUM THERAPY

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Twenty-third Annual Meeting, 1938: To be announced.

EDITORIAL

PULMONARY CHANGES IN UNDULANT FEVER

THE increasing reports of the occurrence of undulant fever would indicate that it is no longer a rare disease. On the contrary, it is being recognized with greater frequency and perhaps a lack of familiarity with its various clinical manifestations has been responsible for its going unrecognized when often present. Simpson,[1] as early as 1930, called attention to the fact that the Health Section of the League of Nations stated that undulant fever is the most important problem facing public health workers. The disease is not limited to any one particular section of this country. As an indication of the increasing frequency of the occurrence of the disease, Simpson says that prior to 1925, 128 cases of undulant fever had been recorded in this country. During the period from 1925 to 1928, the recorded cases numbered 24, 46 and 217 respectively. During 1928, largely due to the dissemination of information regarding the disease, 649 cases were recorded, and an investigation conducted by himself in a nation-wide survey of the number of cases recorded by state health departments during 1929 revealed 1,301 cases, these occurring in every state in the Union.

Bruce, in 1887, established *Micrococcus melitensis* as the etiologic agent in Malta fever. Ten years later, Bang discovered the bacillus of contagious abortion in cattle, and Traum observed a similar organism in cases of contagious abortion in swine. It remained for Alice C. Evans, bacteriologist of the United States Public Health Service, to establish the fact that the *Bacillus abortus* of Bang, the cause of contagious abortion of cattle, and the *Micrococcus melitensis* of Bruce, the etiologic agent in Malta fever, were identical in their morphological, biochemical, cultural and ordinary agglutination reactions, and it was undoubtedly her work which revived the interest in Malta fever. Milk is the greatest source of infection in this country, and the widespread use of raw milk has been responsible for the frequent occurrence of undulant fever.

Undulant fever presents many symptoms and signs common to a number of diseases, particularly typhoid fever, malaria, tuberculosis and influenza, and this probably accounts for the tardiness of diagnosis in some cases. Most writers have reported the predominance of the disease in the male sex, though in Simpson's group of cases the females outnumbered the males. Children are supposed to be relatively immune, though a number of cases have been reported in the early age groups.

Because undulant fever presents such protean manifestations, it has to be considered in a differential diagnosis in many conditions, particularly in those patients who exhibit a prolonged febrile illness showing no positive physical signs, in those patients whose history suggests tuberculosis but all of the clinical signs and laboratory findings are against this diagnosis, and in many cases of unexplained backache or so-called cases of atypical malaria, obscure gallbladder and joint disease, and secondary anemias with chronic ill health. Since it is this group of cases which are so frequently referred to the roentgenologist for a study as to the cause of an unexplained fever there may be an opportunity to help the clinician arrive at a diagnosis at an earlier stage than is frequently done. Particularly is this true in the group of cases of undulant fever which exhibit pulmonary symptoms.

[1] Simpson, W. M. Undulant fever (brucelliasis). *Ann. Int. Med.*, 1930–1931, *4*, 238–259.

Hughes[2] was the first to report the morbid anatomic changes in man in cases of undulant fever. He observed among other pathologic processes patchy areas of pneumonia in the lungs, and in the report of a case, Sprunt and McBryde[3] called attention to the presence of fibrous pleurisy and areas of atelectasis throughout the lungs. Bogart,[4] in a report made in 1936 before the Southern Medical Association on the pulmonary changes in undulant fever, called attention to the roentgenographic appearances of these changes where there were rather massive hilum infiltration, with marked peribronchial thickening and patchy areas of bronchopneumonic consolidation which showed a rather characteristic tendency to be quickly absorbed and to reappear in some other part of the lungs, and he stated that undulant fever should always be thought of in cases showing heavy hilum infiltration, marked peribronchial infiltration or bronchopneumonic consolidation when the history, clinical findings and laboratory data fail to establish the diagnosis of tuberculosis or some of the better known diseases. More recently, Lafferty and Phillips[5] have again called attention to the pulmonary changes in patients suffering from Malta fever, and from an analysis of their cases they were led to believe that the disease often manifests itself in the lungs by peribronchial congestion or a diffuse bronchopneumonic process with rapidly progressing fibrosis.

These lung changes are most likely to be shown should the patient be examined at a time when the pulmonary symptoms are more acute and when there is an increased elevation of temperature. While the pulmonary changes in undulant fever are not typical of the disease process and might be present in other diseases, in those cases where the diagnosis is obscure and the pulmonary lesions are found, the possibility of its being undulant fever should not escape the attention of the roentgenologist.

[2] Hughes, M. L. Quoted by Sprunt and McBryde.

[3] Sprunt, D. H., and McBryde, A. Morbid anatomic changes in cases of brucella infection in man. *Arch. Path.*, 1936, *21*, 217–226.

[4] Bogart, F. B. Pulmonary changes in undulant fever. *South. M. J.*, 1936, *29*, 1–9; also discussion of paper by Lafferty and Phillips.

[5] Lafferty, R. H., and Phillips, C. C. Pulmonary changes in patients suffering from Malta fever. *South. M. J.*, 1937, *30*, 595–600.

SOCIETY PROCEEDINGS, CORRESPONDENCE AND NEWS ITEMS

Items for this section solicited promptly after the events to which they refer.

MEETINGS OF ROENTGEN SOCIETIES*

UNITED STATES OF AMERICA

AMERICAN ROENTGEN RAY SOCIETY
Secretary, Dr. C. B. Peirce, University Hospital. Ann Arbor, Mich. Annual Meeting: Atlantic City, Sept. 20–23, 1938.

AMERICAN COLLEGE OF RADIOLOGY
Secretary, Dr. E. L. Jenkinson, 1439 S. Michigan Ave., Chicago, Ill. Annual meeting, 1938: To be announced.

SECTION ON RADIOLOGY, AMERICAN MEDICAL ASSOCIATION
Secretary, Dr. J. T. Murphy, 421 Michigan St., Toledo, Ohio. Annual meeting: San Francisco, Calif., June 13–17, 1938.

RADIOLOGICAL SOCIETY OF NORTH AMERICA
Secretary, Dr. D. S. Childs, 607 Medical Arts Bldg., Syracuse, N. Y. Annual meeting, 1938: To be announced.

RADIOLOGICAL SECTION, BALTIMORE CITY MEDICAL SOCIETY
Secretary, Dr. Howard H. Ashbury, Baltimore. Meets third Tuesday each month, September to May.

RADIOLOGICAL SECTION, CONNECTICUT MEDICAL SOCIETY
Secretary, Dr. Max Climan, 242 Trumbull St., Hartford, Conn. Meets twice annually in May and September. Special meetings may be called by the Chairman.

RADIOLOGICAL SECTION, LOS ANGELES COUNTY MEDICAL SOCIETY
Secretary, Dr. M. L. Pindell, 678 S. Ferris Ave., Los Angeles, Calif. Meets on second Wednesday of each month at County Society Building.

RADIOLOGICAL SECTION, SOUTHERN MEDICAL ASSOCIATION
Secretary, Dr. Roy G. Giles, Temple, Texas.

BROOKLYN ROENTGEN RAY SOCIETY
Secretary, Dr. E. Mendelson, 120 E. 19th St., Brooklyn, N. Y. Meets monthly on first Tuesday, October to April.

BUFFALO RADIOLOGICAL SOCIETY
Secretary-Treasurer, Dr. Joseph S. Gian-Franceschi, 610 Niagara St., Buffalo, N. Y. Meets second Monday of each month except during summer months, place of meeting selected by the host.

CHICAGO ROENTGEN SOCIETY
Secretary, Dr. R. G. Willy, 1138 N. Leavitt. Meets second Thursday of each month October to May inclusive at the Palmer House.

CINCINNATI RADIOLOGICAL SOCIETY
Secretary, Dr. J. E. McCarthy, 707 Race St., Cincinnati, Ohio. Meets third Monday of each month, October to May, inclusive.

CLEVELAND RADIOLOGICAL SOCIETY
Secretary, Dr. Harry Hauser, 3395 Scranton Rd. Meetings are held at 6:30 P.M. at the Cleveland Chamber of Commerce Club rooms on the fourth Monday of each month from October to April, inclusive.

DENVER RADIOLOGICAL CLUB
Secretary, Dr. E. A. Schmidt, 4200 E. 9th Ave., Denver, Colo. Meets third Tuesday of each month.

DETROIT ROENTGEN RAY AND RADIUM SOCIETY
Secretary, Dr. E. R. Witwer, Harper Hospital. Meets monthly on first Thursday from October to May, at Wayne County Medical Society Building.

FLORIDA STATE RADIOLOGICAL SOCIETY
Secretary, Dr. Harold O. Brown, Tampa, Florida. Meetings held twice a year, May and November.

GEORGIA RADIOLOGICAL SOCIETY
Secretary, Dr. R. C. Pendergrass, Prather Clinic Bldg., Americus, Ga. Meets twice annually: in November and at annual meeting of Medical Association of Georgia in the spring.

ILLINOIS RADIOLOGICAL SOCIETY
Secretary, Dr. Cesare Gianturco, 602 W. University Ave., Urbana, Ill. Regular meetings held quarterly.

INDIANA ROENTGEN SOCIETY
Secretary, Dr. C. C. Taylor, Indianapolis, Ind. Meeting held the second Sunday in May annually.

LONG ISLAND RADIOLOGICAL SOCIETY
Secretary, Dr. S. G. Schenck, 115 Eastern Parkway, Brooklyn, N. Y. Meets at Kings County Med. Soc. Bldg. on fourth Thursday of each month from October to May, at 8:30 P.M.

MICHIGAN ASSOCIATION OF ROENTGENOLOGISTS
Secretary, Dr. C. S. Davenport, St. Lawrence Hospital, Lansing. Three meetings a year, Fall, Winter, Spring.

MILWAUKEE ROENTGEN RAY SOCIETY
Secretary, Dr. S. A. Morton, Columbia Hospital, Milwaukee, Wis. Meets monthly. Place of meeting named by the president.

MINNESOTA RADIOLOGICAL SOCIETY
Secretary, Dr. H. M. Weber, Mayo Clinic, Rochester, Minn.

NEBRASKA RADIOLOGICAL SOCIETY
Secretary, Dr. D. A. Dowell, Medical Arts Bldg., Omaha, Nebr. Meets first Wednesday of each month, at 6 P.M., at either Omaha or Lincoln.

NEW ENGLAND ROENTGEN RAY SOCIETY
Secretary, Dr. E. C. Vogt, 300 Longwood Ave., Boston, Mass. Meets monthly on third Friday, Boston Medical Library.

RADIOLOGICAL SOCIETY OF NEW JERSEY
Secretary, Dr. P. S. Avery, New Brunswick, N. J. Meets annually at time and place of State Medical Society. Mid-year meetings at place designated by the president.

NEW YORK ROENTGEN SOCIETY
Secretary, Dr. H. K. Taylor, 667 Madison Ave., New York. Meets monthly on third Monday, New York Academy of Medicine, at 8:00 P.M.

NORTH CAROLINA ROENTGEN RAY SOCIETY
Secretary, Dr. Major Fleming, Rocky Mount, N. C. Annual meeting at time and place of State Medical Society. Mid-year scientific meeting at place designated.

CENTRAL NEW YORK ROENTGEN RAY SOCIETY
Secretary, Dr. C. F. Potter, 820 S. Crouse Ave., Syracuse. Three meetings a year—January, May, November.

PACIFIC ROENTGEN CLUB
Secretary, Dr. L. H. Garland, 450 Sutter St., San Francisco, Calif. Meets annually, during meeting of California Medical Association.

PENNSYLVANIA RADIOLOGICAL SOCIETY
Secretary, Dr. L. E. Wurster, 416 Pine St., Williamsport, Pa. Two day annual meeting, May, 1938. Exact date and place to be decided.

PHILADELPHIA ROENTGEN RAY SOCIETY
Secretary, Dr. B. R. Young, Temple University Hospital. Meeting first Thursday of each month from October to May inclusive, at 8:15 P.M., in Thompson Hall, College of Physicians, 19 S. 22d St.

PITTSBURGH ROENTGEN SOCIETY
Secretary, Dr. H. N. Mawhinney, Mercy Hospital. Two fall and two spring meetings—time and place designated by the president.

ROCHESTER ROENTGEN RAY SOCIETY, ROCHESTER, N. Y.
Secretary, Dr. Camp C. Thomas, 476 Lake Ave. Meets on second Thursday from October to May, inclusive, 8 P.M., Rochester Academy of Medicine Building.

ST. LOUIS SOCIETY OF RADIOLOGISTS
Secretary, Dr. W. K. Mueller, University Club Bldg. Meets fourth Wednesday of October, January, March and May, at a place designated by the president.

SAN FRANCISCO RADIOLOGICAL SOCIETY
Secretary, Dr. L. H. Garland, 450 Sutter St., San Fran-

*Secretaries of Societies not here listed are requested to send the necessary information to the Editor.

cisco. Meets monthly on first Monday at 7:45 P.M., alternately at Toland Hall and Lane Hall.

South Carolina X-Ray Society
Secretary, Dr. R. B. Taft, 105 Rutledge Ave., Charleston. Meets at time and place of South Carolina Medical Assn.

Tennessee Radiological Society
Secretary, Dr. F. B. Bogart, 311 Medical Arts Bldg. Chattanooga, Tenn. Meets annually at the time and place of the Tennessee State Medical Association.

Texas Radiological Society
Secretary Dr. G. D. Carlson, 3121 Bryan St., Dallas, Texas. Next regular meeting in San Antonio.

University of Michigan Department of Roentgenology Staff Meeting
Secretary, Dr. C. B. Peirce, University Hospital, Ann Arbor, Mich. Meets each Monday evening from September to June, at 7 P.M. at University Hospital.

University of Wisconsin Radiological Conference
Secretary, Dr. E. A. Pohle, 1300 University Ave., Madison, Wis. Meets every Thursday from 4:00–5:00 P.M., Room 301, Service Memorial Institute.

Virginia Radiological Society
Secretary, Dr. V. W. Archer, University Hospital, University, Va. Meets annually in October.

Cuba

Sociedad Cubana de Radiologia y Fisioterapia
Secretary, Dr. Francisco Padron, Enrique, Villuendas 64, Havana, Cuba. Meets monthly in Havana.

British Empire

British Institute of Radiology Incorporated with the Röntgen Society
Meets on the third Thursday of each month, from November to June inclusive, at 8:15 P.M., at 32 Welbeck St., London, W. 1, or as advertised.

Section of Radiology of the Royal Society of Medicine (Confined to Medical Members)
Meets on the third Friday of each month during the winter at 8:15 P.M. at the Royal Society of Medicine, 1, Wimpole St., London, W. 1.

Section of Radiology and Medical Electricity, Australasian Medical Congress
Secretary, Dr. H. M. Cutler, 139 Macquarie St., Sydney, New South Wales.

Radiological Section of the Victorian Branch of the British Medical Association
Secretary, Dr. Keith Hallam, St. George's Hospital, K.E.W., Melbourne, E. 4, Victoria, Australia. Meets monthly from March to Nov. incl. for scientific discussion.

Canadian Association of Radiologists
Secretary, Dr. A. C. Singleton, Medical Arts Bldg., Toronto, 5, Ontario.

Section on Radiology, Canadian Medical Association
Secretary, Dr. C. M. Jones, Inglis St., Ext., Halifax, N.S.

Radiological Section, New Zealand British Medical Association
Secretary, Dr. Colin Anderson, Invercargill, New Zealand. Meets annually.

Continental Europe

Belgian Society of Roentgenology
Secretary, Dr. J. Boine, Avenue des Alliés, 134, Louvain (Belgium).
Meets monthly on second Sunday at d'Egmonds Palace, Brussels, except in the summertime.

Sociedad Española de Radiologia y Electrologia
Secretary, Dr. J. Martin-Crespo, Fuencarral, 7, Madrid, Spain. Meets monthly in Madrid.

Société de Radiologie Médicale de France
Meets monthly on second Tuesday, except during months of August and September, 12 Rue de Seine, Paris.

Société Suisse de Radiologie (Schweizerische Röntgen-Gesellschaft)
Secretary for French language, Dr. A. Grosjean, La Chaux de Fonds.
Secretary for German language, Dr. Scheurer, Molzgasse, Biel.
Meets annually in different cities.

Société Francaise d'Electrothérapie et de Radiologie Médicale
Meets monthly on fourth Tuesday, except during month of August and September, 12 Rue de Seine, Paris.

Association of German Roentgenologists and Radiologists in Czecho-Slovakia
Secretary, Dr. Walter Altschul, German University, Prague, 11.52.

Deutsche Röntgen-Gesellschaft (Gesellschaft für Röntgenkunde und Strahlenforschung)
Meets annually in April, alternating one year in Berlin, one year in some other German city. Meets in addition every two years with the Gesellschaft deutscher Naturforscher und Aerzte.
Permanent Secretary, Professor Dr. Haenisch, Klopstockstrasse 10, Hamburg, Germany.

Süd- und Westdeutsche Röntgengesellschaft
Meets annually in different cities.

Nord- und Ostdeutsche Röntgengesellschaft
Meets annually in different cities.

Dutch Society of Electrology and Roentgenology
Holds two meetings a year in Amsterdam, one in the Spring, and one in the fall.

Societa Italiana Radiologia Medica
Secretary, M. Ponzio, University of Turin, Prof. Turin.

Societatea Romana de Radiologie si Electrologie
Secretary, Dr. Oscar Meller, Str. Banul Mărăcine, 30, S. I., Bucuresti, Roumania.
Meets second Monday in every month with the exception of July and August.

All-Russian Roentgen Ray Association, Leningrad, USSR in the State Institute of Roentgenology and Radiology, 6 Roentgen St.
Secretaries, Drs. S. A. Reinberg and S. G. Simonson, Meets annually.

Leningrad Roentgen Ray Society
Secretaries, Drs. S. G. Simonson and G. A. Gusterin.
Meets monthly, first Monday at 8 o'clock State Institute of Roentgenology and Radiology, Leningrad.

Moscow Roentgen Ray Society
Secretaries, Drs. L. L. Holst, A. W. Ssamygin and S. T. Konobejevsky.
Meets monthly on the first Monday at 8 o'clock, the place of meeting being selected by the Society.

Polish Society of Radiology
Secretary, Dr. Jan Kochanowski, 45 Gornoslazka St., Warsaw. Meets annually.

Warsaw Section, Polish Society of Radiology
Secretary, Dr. B. Krynski, 11 Zielna St.
Meets once a month except in the summertime.

Scandinavian Roentgen Societies
The Scandinavian roentgen societies have formed a joint association called the Northern Association for Medical Radiology, meeting every second year in the different countries belonging to the Association. Each of the following societies, with exception of the Denmark Society, meets every second month except in the summertime:

Society of Medical Radiology in Sweden
Meets in Stockholm.

Society of Medical Radiology in Norway
Meets in Oslo.

Society of Medical Radiology in Denmark
Secretary, Dr. G. Biering, Copenhagen.
Meets on the second Wednesday of each month from October to July in Copenhagen, at 8 o'clock in the State Institute of Roentgenology.

Society of Medical Radiology in Finland
Meets in Helsingfors.

Vienna Roentgen Society
Meets first Wednesday of each month, at 6:30 P.M. at Zentral-Röntgen Institut des allgemeinen Krankenhauses Alserstrasse 4.

Orient

Japan X-Ray Association
c/o Orthopedic Surgery, Tokyo Imperial University. Meets annually in April.

Kinki Roentgen-Abend Society
Director, Dr. Prof. Taiga Saito, Ogawaoike Tyoto Japan. Meets bi-monthly on third Sunday.

CONFERENCE OF EASTERN RADIOLOGISTS

The Conference of Eastern Radiologists was held in Philadelphia, Pennsylvania, on January 28 and 29, 1938, at the Hotel Warwick. The Philadelphia Roentgen Ray Society sponsored the meeting and acted as host. The Conference was well attended, as was evidenced by a registration of about three hundred, and much interest was shown in all of the scientific sessions. One of the distinguishing features of these conferences heretofore, namely the holding of the sessions at various local hospitals, was abandoned this year in favor of a central meeting place. The reason for this was the fact that the ever increasing attendance made the question of adequate accommodation at the hospitals and of transportation most difficult. Whether the policy of a central meeting place will be continued at future conferences will be decided by a vote taken by ballot on the final day of the Conference.

The meeting opened at nine o'clock Friday morning with a welcome by Dr. Elwood E. Downs, the President of the Philadelphia Roentgen Ray Society.

The first paper was "A Case of True Aneurysm of the Right Renal Artery," by Dr. Leon Solis-Cohen, Director of the Department of Radiology, Memorial and Jewish Hospitals, and Dr. Meyer Steinbach, Assistant Radiologist, Memorial Hospital. They briefly reviewed the literature and added their own case (recognized preoperatively) to the 60 on record. No more than 10 of these cases have been diagnosed before operation or death. Most cases have occurred in males, the age incidence varying from nine months to eighty-two years. Syphilis was present in only 3 cases. Most authors believe direct trauma, chronic systemic disease, and arterial degenerative changes to be the main etiological factors.

True and false aneurysms of the renal arteries are about equally divided. Either the main trunk or one of its large or small subdivisions may be affected. They vary in size considerably, true aneurysms being smaller. In the cases caused by trauma, death usually occurred several months to two years following the original accident. The aneurysmal sac ruptures into the renal pelvis, retroperitoneal sac or peritoneal cavity.

The cardinal signs and symptoms are tumefaction, pain, and hematuria; none of these may be present in a given case. A systolic thrill and bruit, though rarely present, are diagnostic. The roentgenograms in 8 of the cases roentgenographed showed a calcified ring shadow within or medial to the kidney, as did the case reported here. In only 3 of these was the diagnosis made preoperatively. True aneurysms must be distinguished from renal calculi, calcified lymph node, calcified cyst or abscess of the kidney; false aneurysms from ruptured kidney, hydronephrosis and renal neoplasm. Renal aneurysms causing symptoms are invariably fatal unless operated upon.

The next presentation on "The Thymus—Notes on Some Studies of its Physiology," was made by Dr. Harry Shay, Gastro-enterologist, Mt. Sinai Hospital, S. S. Fels, and Dr. Jacob Gershon-Cohen. Their work showed that about 2,000 r delivered to the thymus very early in the life of the rat led to very rapid atrophy of the gland. Although similar thymus effects were produced in the two sexes, marked differences in the remote effects resulted in the male and female. In the former, a striking arrest of development of the testes occurred. Histologically, in most instances, there was a complete arrest of spermatogenesis. In the pituitary, the typical picture of the castrate pituitary developed with a marked increase in size and vacuolization of the basophiles. The pituitary picture in the male, they believe, is secondary to the physiological castration produced. Animals to date mated until 200 days of age have shown the males in which the thymus had been destroyed to be sterile. Further studies are under way to determine if this sterility is permanent.

In the female, although the thymus was destroyed just as effectively as in the male, none of the above effects were seen. Histologically, graafian follicles and corpora lutea developed in the ovaries of the thymus treated female that were indistinguishable from those of control litter mates. The estrus cycle, reproduction, and the pituitary were also unaffected. Organ-weight, body-weight ratio of the other endocrine glands was also affected differently in the two sexes. It is concluded from their experiments that the thymus has a different function in the two sexes. This work is pub-

lished in detail in the February, 1938, issue of the JOURNAL.

The next talk was given by Dr. I. S. Ravdin, Harrison Professor of Surgery, University of Pennsylvania, and Dr. J. E. Rhoads, J. Berton Carnett Fellow in Surgery, University of Pennsylvania, on "The Diagnosis and Treatment of Parathyroid Tumors." In a summary of the subject they state that parathyroid adenomas may produce classical osteitis fibrosa cystica or generalized demineralization of the skeleton without bone cysts or may produce no bone changes at all. Nephrolithiasis is frequent and may cause the presenting symptoms in cases with and without bone changes. Cases without pathognomonic roentgen findings require chemical studies for diagnosis. The serum calcium and phosphatase concentrations are usually elevated but cannot be depended upon. The serum phosphate concentration is usually low. The most constant metabolic change is an increased output of calcium in the urine. Consequently hypercalciuria is the most valuable diagnostic sign in doubtful cases. At the present time the only treatment offering permanent cure is surgical excision. The results have been very good although the bone changes are slow to regress and urinary calculi already formed generally require mechanical removal. A summary of 8 cases admitted to the Hospital of the University of Pennsylvania was presented.

The subject of "Air Myelography—The Substitution of Air for Lipiodol in Roentgen Visualization of Tumors and Other Structures in the Spinal Canal" was taken up by Dr. Barton R. Young, Assistant Professor of Radiology, and Dr. Michael Scott, Fellow in Neurosurgery, Temple University Medical School. This paper is published in full in the February, 1938, issue of the JOURNAL.

A timely paper on a new subject was given by Dr. Raymond E. Zirkle, Fellow in Medical Physics, Johnson Foundation, University of Pennsylvania, and Dr. I. Lampe, Instructor in Radiology, University of Michigan. This paper is scheduled to appear in the April issue of the JOURNAL where it may be read in detail.

A very interesting discussion was given by Dr. Boland Hughes, Associate in Urology, University of Pennsylvania, on "Early Changes of Kidney Stones."

A talk on "Movements of Roentgen Opaque Deposits in Heart Valve Areas—Their Relations to Heart Sounds and Auricular Filling" was given by Dr. Charles C. Wolferth, Professor of Clinical Medicine, and Dr. Alexander Margolies, Associate in Medicine, University of Pennsylvania.

Dr. O. H. Perry Pepper, Professor of Medicine, University of Pennsylvania, presented a paper on "Further Observations on Enlarged Parietal Foramina." Two years ago, Pepper and Pendergrass[1] reported observations on two families a number of whose members in four generations exhibited hereditary enlargement of the parietal foramina of varying degrees. The presence in the second of these families of a seven months' infant still with a very large sagittal foramen offered an opportunity for making observations on the process of ossification which converts the sagittal foramen into the two parietal foramina. Roentgenograms at four-month intervals show ossification gradually spreading up the median line, dividing the sagittal foramen into two and reducing these in size. Normally the parietal foramina should by birth remain only as very small openings; in this infant the foramina at the age of three years and two months are still over an inch in diameter. In certain members of these families no further reduction in size occurs.

"The Treatment of Bilateral Pleural Effusion" was the title of a paper given by Dr. Burgess L. Gordon, Associate Professor of Medicine, Jefferson Medical College. The mechanism of bilateral pleural effusions was discussed in the case of a young woman with a history of a long-standing unilateral effusion (exudate) related to a benign growth of the pleura. Artificial pneumothorax had been instituted as a means to control the fluid. After being continued for two years an attempt was made to re-expand the lung by creating a negative intrapleural pressure. This was followed immediately by severe pain in the mediastinum, cyanosis, dyspnea, hernia of the mediastinum, shifting of the trachea and paradoxical movements of the diaphragm. A hemorrhagic transudate developed on the opposite side with further dyspnea. The studies suggested that the high negative intrapleural pressures (-21 to -27) disturbed the mediastinal structures and interfered with normal diaphragmatic function, thus creating a mechanical situation in the opposite chest that allowed fluid to enter the pleural cavity. The accumulation of hemorrhagic fluid was due to a rupture of small superficial vessels in the pleura. The patient improved symptomatically as the intrapleural

[1] Am. J. Roentgenol. & Rad. Therapy, 1936, *35*, 1.

pressures were equalized to within normal limits in both pleural cavities. This was accomplished by removing fluid, introducing air and closely following the events fluoroscopically. The mechanism of pain, paradoxical movements of the diaphragm and mediastinal hernia occurred on three occasions when there was an increase of the negative intrapleural pressure on the left side.

The next paper, by Dr. Herman W. Ostrum, Roentgenologist to the Philadelphia General Hospital, was entitled "Aneurysms around the Sinuses of Valsalva." These aneurysms are rare. A series of 25,000 autopsies, revealed only 7. Syphilis is the usual cause. They are all intrapericardial and intracardiac except those arising in the posterior half of the left sinus. An aneurysm arising from the anterior sinus will enter the upper portion of the right ventricle just below the pulmonary artery and may erode the sternum and protrude anteriorly. The left sinus is in close approximation, anteriorly with the pulmonary artery and posteriorly has an extracardiac relation. Aneurysms, therefore, arising from the anterior half of this sinus will bulge into the pulmonary artery and resemble a congenital heart lesion. Those arising from the posterior portions will bulge extracardially above the pulmonary artery. The anterior portion of the right sinus is in close proximity with the right atrium and the posterior portion with the left atrium. Here also those arising from the anterior portion will bulge into the right atrium, those arising in the posterior portion will bulge into the left atrium. Therefore, in summary, it may be said that aneurysms of the sinus of valsalva are usually due to syphilis, are all intracardiac except those arising from the posterior half of the left sinus, are all within the pericardial sac, and will resemble cardiac aneurysms or congenital heart lesions.

Dr. Henry Tumen, Assistant Professor of Medicine, Graduate School of Medicine, University of Pennsylvania, discussed the subject of "Primary Tuberculous Enterocolitis."

A paper was given by Dr. George P. Muller, Professor of Surgery, and Dr. Howard H. Bradshaw, Instructor in Surgery, Jefferson Medical College, on "Intrathoracic Ganglioneuromas."

The types of neurogenic tumors occurring within the thorax are classified as neuroblastomas, ganglioneuromas, paragangliomas or neurofibromas. The first three are confusing because of their histological structure. All three elements may be present in a single tumor and the predominating cell determines the type.

The neuroblastoma is composed mainly of undifferentiated cells and is highly malignant. Ganglioneuromas are composed of well-differentiated multipolar ganglion cells mixed with strands of medullated and non-medullated nerve fibers and coarsely arranged fibrous tissue, and are benign. Paragangliomas are similar to the tumors arising from the medulla of the suprarenals. Neurofibromas arising from intercostal nerves represent the well known von Recklinghausen tumors.

These tumors arise from the paravertebral "gutter" and in the upper half of the chest. Roentgen examination shows a shadow of even density and a smooth curved outline. Pressure erosion of rib margins above and below the point of origin, especially if arising from intercostal nerves, may be present.

These tumors rarely produce symptoms until they become large enough to produce mediastinal compression as they rarely arise within the lung substance and involve the lung secondarily only later in their growth. Occasionally the tumor grows in the intervertebral canal and causes cord symptoms from pressure.

A brief history of 3 patients with intrathoracic ganglioneuromas was presented illustrated with lantern slides.

Dr. Martin J. Sokoloff, Associate in Medicine, and Dr. John T. Farrell, Jr., Assistant Professor of Roentgenology, Jefferson Medical College, gave an interesting discussion of "Spontaneous Pneumothorax in Anthracosilicosis."

This concluded this morning session. The scientific session was resumed at two o'clock. The first three papers on the afternoon program were as follows:

"The Treatment of Acute Intestinal Obstruction by Intestinal Intubation," by Dr. W. Osler Abbott, Associate in Medicine, and Dr. George W. Chamberlin, Associate in Radiology, University of Pennsylvania.

"Tumors in Cold-Blooded Animals," by Dr. Baldwin Lucke, Professor of Pathology, University of Pennsylvania.

"Malignant Tumors of the Nose and Sinuses," by Dr. Austin T. Smith, Associate in Laryngology, Jefferson Medical College.

The next paper was "A Discussion of the Problem of Roentgen Therapy in Chronic Pharyngitis," by Dr. Harry P. Schenk, Assistant Professor of Otolaryngology, University of Pennsylvania. He stated that the chronically

infected pharynx is capable of acting as a formidable focus of infection. Hyperplasia and chronic inflammatory changes in the lymph nodules constitute the principal pathologic alterations.

Treatment of chronic pharyngitis is a stubborn problem. Iodide therapy and electrocoagulation of the lymph nodules have proved to be the most effective therapeutic agents. From the patient's viewpoint, irradiation is preferable to the prolonged seances with the electrocoagulation needle. The results, however, are often far from satisfactory because, in many instances, the lymphoid nodules are surprisingly resistant to irradiation. When larger doses are used, a deleterious effect may be exerted on the mucous glands, resulting in "dry pharynx."

In reviewing the histories of patients exhibiting unusually good effects following irradiation of the pharynx, it was found that iodide administration had preceded irradiation in each instance. Comparison of a control group, not receiving iodide therapy, with a group receiving iodide therapy for two to three weeks prior to irradiation, gave convincing evidence that irradiation of the chronically infected pharynx, in individuals receiving iodides, was more effective than in individuals not receiving iodides. The combination was far more effective than either irradiation alone or iodides alone.

"The Effect of Hypoproteinemia on the Small Intestine" was the subject of a talk given by Dr. Robert P. Barden, Assistant Instructor in Radiology, University of Pennsylvania. In previous studies it has been shown that the time of gastric emptying in the dog and man is related to the level of the blood serum proteins. Hypoproteinemia with resulting tissue edema may cause pyloric obstruction which can be overcome by restoring blood protein. Patients with chronic gastric disease, who develop postoperative vomiting, may often be spared a second operation by protein therapy. Dogs rendered hypoproteinemic show marked delay in the passage of a barium meal through the small intestine. This phenomenon is independent of the delay in gastric emptying. It is probably associated with the same latent tissue edema. Concomitant with the altered small intestinal physiology, there is a change in the small intestinal pattern. This change is proportional to the serum protein level. When the blood protein is restored to normal, the intestinal pattern returns to normal. Alterations in the anatomy and physiology of the gastrointestinal tract due to chronic inanition, chronic bleeding, or diseases reducing blood protein, may complicate the surgical or medical management of any patient.

"The Congenitally Short Esophagus" was discussed by Dr. Louis H. Clerf, Professor of Laryngology and Bronchoscopy, Jefferson Medical College. He stated that congenitally short esophagus with a portion of stomach in the thorax although considered by some as a hernia must be differentiated particularly if surgical treatment is contemplated. It cannot always be recognized by the roentgenologist even when studies are made in the right-oblique-prone posture or in the Trendelenburg position since it simulates certain forms of hiatal hernia. Esophagoscopic findings are important. A common finding is stenosis of the esophagus usually at the level of the eighth thoracic vertebra. Beyond this there is observed gastric mucosa. There is no redundancy of esophageal wall proximal to the junction of esophagus and stomach. Repeated examinations reveal no change in the position of the esophagogastric junction.

Dr. George E. Pfahler, Professor of Radiology, Graduate School of Medicine, University of Pennsylvania, and Dr. Jacob H. Vastine, Clinical Professor of Radiology, Woman's Medical College, presented the subject of "The Roentgen Interpretation of Lower Spine Injuries, with Special Reference to Spondyloschisis." A recent experience with 4 cases of traumatism to the lower lumbar spine and the difficulty in evaluating the damages done by the recent injury prompted their presentation of this subject. The first of these cases had a very slight injury in an automobile accident. There was found by roentgen examination a spondylolisthesis but the roentgenogram showed clearly also a neural arch defect in the interarticular process on both sides. The patient was awarded $15,000.

The second case had no injury, but had had pain in the back all her life, and showed a similar condition involving the third lumbar vertebra.

The third case had a fracture of the pelvis and a similar involvement of the fourth lumbar vertebra was found, but the patient at no time previously or following the accident had any symptoms referable to the back.

The fourth case had a slight injury and a slight spondylolisthesis of the fourth lumbar

vertebra which was found to be due to a spondylitis, aggravated by a fall while stepping from a chair. She has obtained relief from roentgen treatment.

The authors believe that more than average detail study should be made in connection with these lower spinal injuries which will be helpful in evaluating damages and also serve more completely in outlining treatment.

The subject of the next paper, by Dr. Philip D. Gilbert, Resident in Radiology, Philadelphia General Hospital, was "Bone Necrosis—A Correlation of Total Intensities of Radium and Roentgen Rays and an Interpretation of Complicating Factors of Cancer and Infection." In a recent review of 234 cases of intraoral cancer treated in the Radium Clinic of the Philadelphia General Hospital during the past five years ending 1937, it was found that 11 cases (5 per cent) of the total cases studied, when secondarily infected, developed bone necrosis following treatment with roentgen rays and radium. The mandible was the bone principally involved. Extraction of teeth about the area of malignant disease was attributed to be the locus for foci of infection. Necrosis was observed in those cases in which dental extractions were performed six to twelve months after institution of therapy but did not occur in those that received equal doses of combined deep roentgen therapy and radium, *if extraction of teeth occurred immediately before or after treatment.* A uniform skin dosage of 3,000 r plus an average total surface application of 2,000 mc-hr. was given as a minimum. Undoubtedly, irradiation produces bone changes of a probable vascular character, diminishing the reparative properties following the trauma of extraction. This so-called radiation necrosis is probably the end-result of a radiation periostitis complicated by infection.

"Chemical Specificity in Growth and Development" was discussed by Dr. Stanley P. Reimann, Director of the Research Institute of the Lankenau Hospital. Chemical specificity in growth and development is a part of the big problem of the chemical and physical background of morphogenesis. The original question discussed was: Inside of cells are numbers of different chemical compounds. What do they do in relation to growth and development? Answers were given showing that various of the amino acids and certain nuclear compounds each have a specific function in growth and development of cells.

An important paper on "The Treatment of Carcinoma of the Larynx" was presented by Dr. Gabriel Tucker, Professor of Bronchoscopy and Laryngeal Surgery, University of Pennsylvania. This paper is to be published in a future number of the JOURNAL.

Dr. Joseph McFarland, Emeritus Professor of Pathology, University of Pennsylvania, discussed "The Roentgen Diagnosis of Tumors of the Breast." He stated that it was not the purpose of his remarks to report anything new, but to call attention to the advisability of pursuing information that may afford the surgeon additional aid in diagnosing the nature of vague lumps in the breast. He has several times seen roentgenograms of such lesions from which it was quite possible to make the diagnosis, but he has found his colleagues reluctant to add the roentgenogram to their routine studies, saying that it tells nothing and increases the expense to the hospital or to the patient. Dr. McFarland believes that this is a mistaken attitude for although the information given by the roentgenogram often completely fails, there are some other cases in which non-carcinomatous lesions can be recognized with reasonable distinctness. If a vague "lump" in the breast can, by the roentgenogram, be shown, within reasonable limits of doubt, to be a cyst or an intracystic papilloma or an adenofibroma, or some other non-carcinomatous lesion, much has been gained. It is as useful to know what is *not carcinoma* as what *is carcinoma*, for if all of the former could be excluded, nothing but the latter would be left. It therefore seems worth while to make careful and systematic roentgenograms of all breast lesions and study them carefully, in the hope that familiarity with the appearances presented may eventuate in a more accurate diagnosis, thus saving patients whose lesions are benign from expense, mutilation and loss of time.

The next paper on "Acute Secondary Parotitis" was given by Dr. Walter Estell Lee, Professor of Surgery, Graduate School of Medicine, University of Pennsylvania, and Dr. Robert R. Impink. They collected a series of 59 cases of acute parotitis, which occurred in the years 1927 to 1937 inclusive, from the Pennsylvania, Graduate, Germantown, Burlington County and Bryn Mawr Hospitals. The ages of these patients varied from three to seventy-six years, with an average of 42.5 years. Twenty-nine cases occurred in men and 30 in women. Abscesses developed in 22 cases, and

of these 16 were incised and drained. The mortality in the cases with abscess formation was 30.4 per cent compared with 22.2 per cent in those without abscess formation.

In this series 28 cases developed postoperatively while 31 occurred as primary infections or following various medical conditions. The mortality in the former group was 30 per cent and in the latter 20.6 per cent. The difference in these figures is large enough to be significant. The existence of concomitant surgical conditions of the gastrointestinal tract, kidney or pelvic organs serious enough to require operative intervention probably accounts for the higher mortality.

The treatment was symptomatic in all cases and in addition roentgen therapy was carried out in 19 cases. Unfortunately, the majority of the records fail to state the amount of roentgen radiation administered, so it is difficult to judge whether the dosage was adequate. However, the mortality in the cases which received roentgen therapy was 21.0 per cent, while in those treated by other methods the mortality was 27.5 per cent. In two hospitals, 7 consecutive cases given roentgen treatment recovered. Thus there is demonstrated a decided advantage in prognosis in those cases treated with roentgen irradiation. A more prompt institution of irradiation in several of the earlier cases in the group would probably have resulted in a further decrease in the mortality rate. The gross mortality rate of 25.4 per cent for the entire series, regardless of the type of treatment, is extraordinary in view of the much higher figures reported by other authors. They conclude from a study of their 59 cases that (1) acute secondary parotitis is a rare but serious complication of major surgical operations and of debilitating illnesses; (2) the etiological mechanism is probably an ascending infection of Stenson's duct at the time of generally lowered vitality of the patient; (3) radium treatment of parotitis reduced the mortality rate by about one-half, and (4) roentgen therapy has certain definite advantages over radium treatment and is equally efficacious.

The two concluding papers on the Friday afternoon program were: "Tuberculous and Non-tuberculous Pulmonary Infection and Their Relations" by Dr. Maurice F. McPhedran, Director of Research Department for Pulmonary Diseases, Germantown Dispensary and Hospital, and "A Multiplane Fluoroscope and Novel Type of Ceiling Suspension" by Dr. W. Edward Chamberlain, Professor of Radiology, Temple University Medical School.

The scientific program was resumed Saturday morning at nine o'clock with a paper by Dr. David M. David, Professor of Genito-urinary Surgery, on "The Importance of Roentgen Study of the Ureter." In evaluating ureterograms, the importance of kinks is to be minimized. They are of moment only if obstructing as shown by ureterectasis above. Ureterectasis shown by reflex from a cystogram always means obstruction below the bladder. Both ureters should always be studied, as obstructions are often bilateral. If obstruction is present on the sound side in a patient who is to have nephrectomy, this obstruction, however slight, must be treated. Slight obstructions may lead to grave trouble in after years. Cure of ureteral obstruction may relieve symptoms even if stone is present in the kidney. Pyeloureterograms made by injecting medium through nephrostomy tubes ("descending urograms") may be very valuable in diagnosis, prognosis and treatment. If pyoureter is present, ureter as well as kidney must be removed. Roentgenograms and specimens were shown from 18 illustrative cases.

The next paper was by Dr. Lewis C. Scheffey, Associate Professor of Gynecology, Jefferson Medical College on "Changing Phases in the Treatment of Carcinoma of the Fundus Uteri." He believes that today most gynecologists recognize the desirability of preliminary irradiation when treating carcinoma of the fundus. Whether complete hysterectomy follows depends upon the extent of the disease, the cell type, and the patient's status as an operative risk. The plan followed in the Gynecologic Department, Jefferson Medical College Hospital, is as follows: Given a suspected case, 50 or 100 mg. of radium is available at the time of diagnostic curettage. Dependent upon the gross findings, one or both capsules are placed within the uterine cavity pending the study of rapidly prepared paraffin sections of the curettings. If cancer is present, the radium remains *in situ* for an optimum time; otherwise a limited dosage, suitable for a benign lesion, is employed. Subsequent hysterectomy, if not contraindicated, is performed eight to ten weeks later. Otherwise further irradiation is relied upon. The danger of treating uterine bleeding with irradiation, without excluding carcinoma by diagnostic curettage, cannot be emphasized too forcefully. Statistical tables accompanied the presentation.

Dr. Bernard P. Widmann, Chief Radiologist, Philadelphia General Hospital, gave a talk on "Further Observations on the Use of Low Voltage Roentgen Rays for Superficial Cancers of Wide and Deep Involvement." A systematic procedure of fractional doses of low voltage roentgen rays (130 kv.) was discussed. Clinical experience has shown the futility of attempting to plan treatment with any degree of mathematical precision except on the basis of lesions that were estimated to be shallow or presenting fungations in excess of 0.5 cm. elevation above the surrounding skin margin. A predetermined plan of treatment for a shallow or exuberant lesion is based on a total of 3,200 r and 4,800 r respectively. The first treatment is given without filter (500 r = 1 S.E.D.). The second and third treatments are given with 1 mm. Al filter (550 r = 1 S.E.D.). For simplicity the techniques for shallow or large fungating lesions are referred to as the 2–2–2 S.E.D. or the 3–3–3 S.E.D. The surface areas range from 5 to 10 cm. in diameter. Three treatments are given in one week and every other day. Distances of 40, 30 and 25 cm. with no filtration show little differences in depth penetration. Approximately one-half the radiation is absorbed in the first centimeter of tissue. The depth dose at 3 cm. is 60 per cent and 40 per cent respectively for 1 mm. Al and no filtration. While this technique is applicable for the average skin cancer, it is specifically recommended for large inoperable cancers which are for the most part hopeless, and the effect of the massive doses is almost entirely palliative. The result is frequently equal to a free and wide cautery dissection. The treatment is well tolerated by very sick and aged individuals. It is economical, speedy and in some instances there is complete regression with resultant so-called clinical cures.

A paper by Dr. Hugo Roesler, Associate Professor of Roentgenology and Cardiologist in the Department of Medicine, Temple University Medical School, was on "Correlation between Anatomy and Roentgenology of the Cardiovascular System." The heart has been dissected out either by opening the cardiac cavities in the traditional fashion; this is particularly helpful in the study of disease of the valves; or by carrying out horizontal sections such as used in the courses of anatomy and in particular for the study of the distribution of cardiac infarcts. Neither of these methods has been very helpful for the purpose of correlating roentgenological with post-mortem findings. A new method has been worked out which teaches a better understanding of the silhouette borders as well as of the inner topography.

The heart and great vessels of patients who had been roentgenographed during life were removed after death and kept floating in formalin for several days. Roentgenograms had been taken usually in several directions and this afforded an opportunity for an approximately correct position of the specimen. The specimen was then placed corresponding to the anterior or to one of the two oblique anterior views, depending on which position promised the greatest amount of instruction. Longitudinal sections were then taken, i.e., sections which were parallel to the plane of the film. Three or four sections were thus obtained and then photographed from both sides. Thus, if the roentgenogram depicted the right anterior oblique view, the photographed specimens referred to the right anterior and left posterior oblique views.

Slides have been used in teaching students anatomy and pathology of the cardiovascular system as revealed roentgenographically.

The next paper was by Dr. Thaddeus L. Montgomery, Associate Professor of Obstetrics, Jefferson Medical College, on "The Management of Obstetrical Hemorrhage and the Rôle of the Roentgen Ray."

The subject next presented was by Dr. Francis D. W. Lukens, Director of the George S. Cox Medical Research Institute, University of Pennsylvania on "The Differential Diagnosis of Adrenal Tumors." The variation in the symptoms of adrenal cortical tumors was reviewed in relation to 2 proved cases. The problem of differential diagnosis with special reference to roentgenologic studies was discussed according to the following outline (p. 470).

The symptoms associated with adrenal tumors also occur in certain tumors of the pineal, pituitary, thymus and ovary. The importance of roentgenographic examinations in these conditions is apparent even from this brief list of studies, which includes the examination of local areas for tumor and the observation of the diffuse or generalized abnormalities such as decalcification, metastasis, etc. Many of these symptoms and signs may be present when there is no gross endocrine disease, a fact which emphasizes the need for good judgment in the management of these patients.

"Perirenal Air Injection for the Demonstration of Adrenal Tumors" was the subject of a

DIAGNOSIS OF ADRENAL TUMORS

Symptoms	Differential Diagnosis	Roentgen Findings	
		Local	General
Hirsutism (Virilism)	Pineal	Pineal calcification Pressure signs Encephalogram	Decalcification Arteriosclerosis
Obesity Amenorrhea	Pituitary	Sella Therapeutic test of irradiation	State of epiphyses Metastasis
Striae	Thymus	Thymic enlargement	
Hypertension	Ovary		
Decalcification Glycosuria	Adrenal cortex	Urogram Air injection	
Polycythemia Arteriosclerosis	No endocrine disease	Clinical judgment Elimination of above causes	

talk given by Dr. George W. Chamberlin, Associate in Radiology, University of Pennsylvania. Thirteen female patients clinically suspected of endocrine dysfunction were studied by perirenal air injection. In 2 of these, a tumor of the adrenal was found and later proved at operation. The roentgen technique for examination after the injection of air should consist of films made in the anteroposterior oblique and erect positions at definite intervals until satisfactory examination is obtained or until all the air is absorbed. Roentgenograms show the value of complete examination in the differential diagnosis of soft tissue tumors in the upper abdomen. Errors in technique are not uncommon and their recognition is important. Some of the films presented showed free air in the peritoneal cavity and air in the perihepatic region and mediastinum.

Following a short intermission, the program was resumed with a paper by Dr. Richard Manges Smith, Demonstrator of Roentgenology, Jefferson Medical College, on "The Roentgen Treatment of Fissured Nipples."

A talk on the "Treatment of Hemangioma" by Dr. William S. Newcomet, Director of the Radium Department, Jefferson Medical College, was illustrated by a large number of patients. They were presented in groups to illustrate some facts that are not accepted by the profession.

Emphasis was placed on the following points: (1) Always to secure a careful history and photographs; it is surprising to see how many other defects will be discovered and how the patient and friends will forget the original appearance. (2) Results of treatment can only be estimated after several years have elapsed. One group illustrated cases where large masses were found upon the face, and another group showed the masses upon the head; all the lesions have disappeared with practically no scarring. Cases with lesions of the tongue were treated simply to control the bleeding. Cases depicting scarring, considerable deformity and recurrence of the tumor, which came with loss of function from previous operations, yielded easily to irradiation.

A number of films were shown to illustrate bone changes from irradiation in contrast to those seen from the hemangioma.

In conclusion, the axiom should be: irradiate first; operate only when necessary, for it must be remembered that at times marked extension of the tumor may follow operative interference.

The next paper was "Roentgenological Aspects of Lymphopathia Veneria" by Dr. Arthur Finkelstein, Acting Director of the X-ray-Radium Department, Graduate Hospital.

A preliminary report was given by Dr. Leon Solis-Cohen, Director of the Department of Radiology, Memorial and Jewish Hospitals, and Dr. Samuel Levine, Associate in Radiology, Jewish Hospital, on the "Roentgen Treatment of Lobar and Bronchopneumonia in Adults and Children." They stated that two objectives in irradiating pneumonia patients are (1) to depress the fever for reasons of pathological physiology to moderate levels and (2) to promote and hasten autolysis or resolution in a consolidated lung.

The theory, literature, and background were reviewed and confirmation was given to Powell's work.

Treatment was given at the bedside and in the X-ray Department. The factors at the bedside were 80 kv. (peak), 5 ma., 2 mm. Al, skin-target distance, 10 inches, 100 r to an anterior and posterior field on each of two or three successive days. The factors in the department for children were 100 kv. (peak), 100 r, 2–3 mm. Al, anterior and posterior fields at one sitting, skin-target distance, 12 inches. The factors in the department for adults were 160–200 kv. (peak), 0.5 mm. Cu and 1 mm. Al, 165 r, anterior or posterior field, repeated the next day.

Temperature and leukocytosis are reduced,

and the patient subjectively improves. This is called the favorable syndrome, and treatment is stopped when it develops. It may develop after one treatment. A total of from 300 to 350 r should suffice.

Twenty-seven cases of lobar pneumonia and 3 of bronchopneumonia have been treated to date, with a death rate of approximately 10 per cent. Bacteriemia, empyema, otitis media were not avoided or averted. In 4 cases the pneumonic process was aborted. Serum was given in only 1 case. Early adequate treatment is essential, that is, within the first four days. Treatment in the department is preferred. A plea was made for others to use the treatment where serum is not obtainable or unavailable for the type of infection. All cases in adults were typed. It is also recommended as an adjuvant to serum treatment.

The next paper was "Serum Phosphatase as an Aid in the Diagnosis of Metastatic Malignancy of the Liver" by Dr. Maurice M. Rothman, Instructor in Gastro-enterology, Graduate School of Medicine, University of Pennsylvania, Dr. David R. Meranze, Director of Laboratories, Mt. Sinai Hospital, and Dr. Theodore Meranze, Assistant Director of Laboratories, Mt. Sinai Hospital. No previously proposed test has proved useful in the specific diagnosis of cancer of the liver. The recently introduced serum phosphatase determination is believed to provide such a test. A series of 50 cases of cancer were studied, of which 30 represented proved cases involving the liver. In 29 of these 30 cases, definitely elevated phosphatase values were obtained; 19 of this group showed normal serum bilirubin values. The remaining 20 were cases of cancer without liver or bone involvement. These showed normal serum phosphatase values—evidence that cancer *per se* is not a sufficient cause for the elevation of serum phosphatase. In the absence of jaundice and of other known causes for the elevation of the phosphatase value of sera and in the presence or suspicion of a malignant process the authors feel that an elevated serum phosphatase suggests the diagnosis of cancer of the liver. This test is therefore offered as an aid in the diagnosis of cancer of the liver.

The next two papers on the program were "The Treatment of Carcinoma of the Breast by Interstitial Irradiation" by Dr. Roscoe W. Teahan, Medical Director, Jeanes Hospital, and "The Veins of the Sacrum in Relation to Metastatic Carcinoma from the Prostate" by Dr. Oscar V. Batson, Professor of Anatomy, Graduate School of Medicine, University of Pennsylvania.

This concluded the scientific program and the meeting was adjourned. Washington, D. C. was chosen as the place of meeting in 1939 for the Conference of Eastern Radiologists.

INTERNATIONAL CANCER CONGRESS

The Third International Cancer Congress under the auspices of the International Union against Cancer will be held in the United States, September 11 to 16, 1939, at Haddon Hall, Atlantic City, New Jersey.

The President of the Congress is Professor Francis Carter Wood, Director of the Institute of Cancer Research of Columbia University, New York City; Dr. Donald S. Childs of Syracuse, New York, is the Secretary-Treasurer; and Dr. A. L. Loomis Bell of Long Island College Hospital, Brooklyn, New York, is in charge of transportation and exhibits.

The proposed sections are as follows: general research; biophysics; genetics; general pathology of cancer; surgery of cancer; roentgenological diagnosis of cancer; radiotherapy of cancer; statistics, and education. Further details concerning section chairmen, committees and other data will be announced later.

The membership fee will be $15. All inquiries should be addressed to the Institute of Cancer Research, 1145 Amsterdam Avenue, New York, N. Y.

HICKEY MEMORIAL LECTURE

The second annual Hickey Memorial Lecture was delivered in Detroit on February 14, 1938, by Dr. George W. Holmes, Clinical Professor of Roentgenology, Harvard University Medical School, Boston, his subject being "Hemoptysis and the Place of the Roentgen Examination in its Diagnosis." This lecture was established in 1937 by the Detroit Roentgen Ray and Radium Society in honor of the late Dr. Preston M. Hickey, Professor of Roentgenology, University of Michigan Medical School.

BOOK REVIEWS

Books sent for review are acknowledged under: Books Received. This must be regarded as a sufficient return for the courtesy of the sender. Selections will be made for review in the interests of our readers as space permits.

THE COLLAPSE THERAPY OF PULMONARY TUBERCULOSIS. By John Alexander, B.S., M.A., M.D., F.A.C.S., Professor of Surgery, University of Michigan; Surgeon-in-Charge, Division of Thoracic Surgery, Department of Surgery, University of Michigan Hospital. Cloth. Price, $15.00. Pp. 705, with 367 illustrations. Springfield, Illinois: Charles C Thomas, 1937.

It is strange that a disease which has been known to exist for centuries, and which yearly takes many lives, should be viewed with such relative absence of alarm by large numbers of physicians. It is equally strange why, in the minds of many persons, tuberculosis, though a serious disorder, remains one in which too little thought is given to definite therapy, and in which the physicians feels that bed rest and mountain air are all that is necessary.

If such perversion of thought is the result of ignorance of the existence of collapse therapy, then the publication of this fine work is most fortunate. If doubt remains as to the adequacy of collapse therapy measures to control pulmonary tuberculosis, then its publication is equally fortunate.

The student of pulmonary disease will delight in spending long hours in reading this work. Those less familiar with the subject, but who seek knowledge of it, will be equally gratified by its clear style, the ease, and still thoroughness, with which each angle of collapse therapy is presented. An interesting and extremely helpful system of cross references within the text makes the oftentimes annoying process of finding in the index all the references to any certain subject unnecessary.

The detail with which the subject is covered is astounding. To one relatively familiar with the subject, such detail at times appears pedantic. However, the author has desired to present a work which, in covering the subject of collapse therapy, would be all inclusive. By so doing, he has performed a fine service, well done.

The content is an accumulation of all that has been done in the field of collapse therapy over many years. It starts with a résumé of the history of treatment and then passes on through its physiological and pathological aspects to an excellent discussion of indications and active treatment.

Of great interest to the reviewer was that section under choice of operation in which over one hundred pen and ink drawings with a brief explanatory text gives an outline of treatment which most excellently covers, in general, the whole field of treatment. It is difficult for one acquainted with the subject to find a case not covered in this group. It seems to me that this group alone is worth the price of the book.

There have been numerous works on collapse therapy, but many have presented a mass of data leaving the bewildered reader, after long hours of reading, at last to solve the problem by himself. Alexander has discussed fully the views of others, and the evolution of modern thought in the treatment of pulmonary tuberculosis; and then from a long and large clinical experience, scientifically approached, he condenses the material, and gives a clear, logical reason for the various methods used. It has always seemed to the reviewer that collapse therapy is a most logical procedure; he is sure that many more will feel so after study of this book.

Pinner has given an excellent, clear, and concise explanation of the physiological and pathological aspects of collapse therapy. He has covered, in a small space, a large subject; still it is all there, and well done.

Barnwell, in his chapters on pneumothorax, has done a fine work. He has stressed its values and its dangers. He has shown pneumothorax to be an extremely useful procedure, but one to be approached with knowledge and understanding of the disease treated, and the principles which underlie treatment.

As befits so fine a text, the book itself is attractively bound, and the printing, paper, and illustrations are extremely fine.

Thus, at last comes a book which answers a great need, but it has not alone answered that need; it is a distinct contribution to all that is good and great in medical literature. It contains the experiences of many, molded into

shape by the authors' knowledge, which likewise has come through an active experience with collapse therapy. It has been carefully done; it should be carefully read.

William M. Tuttle

Anales del centro de investigaciones tisiologicas. Edited by Professor Roque A. Izzo. The Year 1936. Paper. Pp. 526, with numerous illustrations. Buenos Aires: Pabellon "Las Provincias," Hospital Tornú, 1937.

This book, a collection of excellent papers from workers in the Institute of Professor Izzo, deserves the attention of those interested in tuberculosis and in the views of this prominent center in Buenos Aires. Since it is impossible to abstract the book without going into undue length, it is suggested that it be consulted in the original, an easy task, because the excellence of the reproductions and the summaries in Spanish, English, German and French permit one to obtain the meat of each article with a minimum of effort. The whole makeup of the book leaves little to be desired.

E. T. Leddy

Principles of Roentgenological Interpretation. By L. R. Sante, M.D., Professor of Radiology, St. Louis University School of Medicine; Radiologist to St. Louis City Hospital and St. Mary's Hospital, St. Louis. Cloth. Price, $5.50. Pp. 340, with 333 illustrations. Ann Arbor, Michigan: Edwards Brothers, Inc., 1937.

Only a few really good elementary books on diagnostic roentgenology have hitherto been available, and the professor of roentgenology in the medical school has usually been forced to indicate one of them as collateral reading and to outline a course of his own. Recognizing a need for a teaching text, Sante has produced one which has many advantages over its predecessors. To be in line with demand for a low cost publication this book is "lithoprinted" in inexpensive style yet bound with board covers sufficient to preserve it for later reference and library use.

As is natural in a work of this type, fundamentals and usual cases are stressed and rare cases are left for more comprehensive reference works. Important phases of examination and diagnosis are printed in large type. Less important and more rare conditions are described in smaller type so the student may readily differentiate between them and not place undue emphasis on the minor subjects at the expense of the major.

With few exceptions the author has illustrated the text with simple drawings which clearly show the lesion in question without confusion of other shadows and free from poor detail usual in reproductions. With fundamentals in mind, the student will have little difficulty transferring his knowledge to a study of negatives. The method of diagrams lends itself well to the chapters on bone pathology, especially fractures, and little fault can be found with the diagnostic principles laid down. The author's statement that wood splints are preferable in fractures of the upper extremity will find opposition from users of plaster molds, and his opinion regarding lasting disability from non-bony union of transverse processes would be challenged by many traumatic surgeons of wide experience.

Fractures, bone diseases, anomalies, tumors and arthritis are of such importance in an elementary knowledge of roentgen diagnosis that they are properly given half the space in the volume. The chest and the gastrointestinal, biliary and urinary tracts share the second half with a chapter on special methods of procedure in diagnosis of diseases of sinuses, mastoids, central nervous system, etc. As would be expected by one familiar with the author's book on the chest and his other works, these subjects are all well covered.

A feature of the book adding not a little to its value to the student is the quiz at the end of each chapter in which important points are emphasized. Many older roentgenologists not caring to study the text in detail would find profit in looking over these questions and endeavoring to answer them. Numerous blank pages are provided on which additional notes or observations may be made. By preparing this very excellent volume Sante has done a real service to roentgenologists and especially to those interested in teaching and to those just entering upon the study of the speciality.

E. Walter Hall

Radiokymographie du coeur et des vaisseaux. Par Emile Bordet et H. Fischgold. Paper. Price, 30 fr. Pp. 134, with 66 illustrations. Paris: Masson et Cie, 1937.

This work is a product of two pupils of the great French cardiologist, the late Vaquez, at

the Pitié in Paris. In the introduction they point out the advantages and limitations of the teleroentgenogram, fluoroscopy, and cineroentgenography and indicate the additional help which roentgen kymography as developed by Stumpf may give. They believe kymography is not only a method of physiological research, but of practical clinical value as well.

The principle of roentgen kymography is ascribed to Sabath and its use to Gött and Rosenthal in 1912. Stumpf is given full credit for his contribution of the multiple slit technique (1928) which gave so much impetus and value to kymographic studies. The further developments of the kymoscope and the densograph are described as is Stumpf's monograph.

A number of chapters is devoted to the findings in the normal heart, emphasis being placed on the value of the kymograph in separating the various chambers of the heart as they appear on the left contour and in offering a precise basis for cardiac mensuration. The authors find the normal amplitude of the pulsation of the left ventricle to lie between 3 and 6 mm. While the great variation of the curves among normal individuals is admitted, the curves for one individual are regarded as remarkably characteristic and constant under the same physiological conditions. The four main physiological conditions which may modify the curves are (1) respiration, (2) the position of the individual, i.e., whether erect or prone, (3) air in the stomach, (4) the rate of the heart beat.

The kymogram reveals motion of the heart contour accurately only when the motion is parallel to the grids. Motions occurring at angles to the horizontal are distorted as the angle increases. Only phenomena of a duration in excess of 1/100 or even 1/30 of a second are recorded. The movements of the auricle are not always pure, often being complicated by movements of the pulmonary artery and other neighboring organs. Stumpf found the curves in this region totally illegible in about one-third of the cases. The curves on the right side of the heart are far from having as regular an appearance and as clear an interpretation as those on the left border. The aortic pulsation is the most definite of all and this forms a proper basis for reading the curves in other portions of the kymogram. Its motions are, of course, contrary to those of the ventricle. The aortic curve is due in large part to a shift in the position of the aorta and only in small degree to the actual distention of the aorta.

Pathological changes manifest themselves in the contour of the image as a whole as well as in peculiarities of the pulsation curves. The pulsation curves are studied in regard to (1) their duration and amplitude, (2) the height and rhythm of the systoles, (3) the depth and intervals of diastoles. The point G which is the junction of the auricular and ventricular segments on the left border is readily determined, and this may be of value as it occupies a low position in mitral disease and a high position in lesions producing a strain primarily on the left ventricle. The authors believe that alterations of the curves in the different valvular and mechanical lesions only serve to confirm and supplement a diagnosis already made by auscultation and other methods. The curves are of more value in giving evidence of functional insufficiency of the heart muscle.

In insufficiency of the left ventricle, an increased amplitude of the pulsation indicates a stage of active dilatation and does not represent permanent myocardial damage. On the other hand, a diminution of the amplitude signifies a passive progressive dilatation. An M-shaped curve is described as a frequent but not invariable or conclusive finding in cases of hypertension with myocardial failure.

The finer details of rhythm and propagation of the wave of contractility are best studied by the electrocardiogram. The kymogram is helpful in giving information not strictly chronological but more regarding the tonicity and contractility of the cardiac fibers.

Schilling was the first author to describe the kymographic picture of an infarct of the myocardium. The pulsations in the infarcted area are much diminished or may be actually reversed, that is there may be an expansile movement in the affected area during the systolic contraction of the healthy muscle.

In pericarditis the pericardial effusion obscures the pulsations of the heart but the pulsations of the aorta persist intact. If there is also dilatation of the heart the pulsations will be equally feeble in the heart and great vessels. In adhesive pericarditis, even with extensive calcification, there may be no alteration in the pulsation and movement of the heart (Codet and Bonte).

The kymogram may give valuable information regarding the exact location of foreign

bodies in the region of the heart inasmuch as the character of their motion indicates whether they lie within the heart cavity, intramurally, or in the lung.

As stated above, the aortic curves on the kymogram represent for the most part a movement of the whole vessel rather than a distention due to the wave of passing blood. An increased amplitude of excursion is seen in emotional states and in cardiovascular erethism. In such cases there is a similar exaggeration of the ventricular excursions. The aortic pulsation is affected by the rigidity of neighboring structures and by the rigidity of the aortic wall as well as by differences in the pulse pressure. In reaching a diagnosis the density, tortuosity, and caliber of the aortic shadow must be considered as well as the amplitude of the pulsations. In the differentiation of aortic aneurysms from mediastinal tumors, kymography offers supplementary but not conclusive information. The absence or presence of a pulsation is not a reliable diagnostic point. The value of kymography lies more in the ability to distinguish various contours and relate them to recognizable structures. An increased amplitude of the pulsation in the region of the pulmonary artery may indicate insufficiency of the pulmonic valves, mitral stenosis, adhesive pericarditis, congenital lesions or chronic pulmonary emphysema as well as primary lesions of the pulmonary artery.

Following the chapters on the clinical applications of kymography are four chapters dealing with the more strictly physiological problems of cardiovascular dynamics. The kymographic findings in the Valsalva experiment, on compression of the carotid sinus, and during exercise are described and illustrated.

This volume may be recommended as a sound and conservative estimate of the present status of cardiovascular kymography.

William A. Evans, Jr.

Diagnosis and Non-operative Treatment of the Diseases of the Colon and Rectum. By Gottwald Schwarz, M.D., Professor University of Vienna; Head X-Ray Department, Kaiserin Elizabeth Hospital, Vienna; Jacques Goldberger, M.D., Consulting Physician, Carlsbad; and Charles Crocker, M.D., New York. Cloth. Price, $10.50. Pp 540, with 246 illustrations and 9 colored plates. New York: Paul B. Hoeber, Inc., 1937.

The method of compilation utilized in this volume approaches an ideal which should be adopted by more authors of textbooks. The material is collected from medical centers of note in Austria, Belgium, Egypt, England and America, and an attempt is made to correlate the information obtained from these widely scattered locations into a simple, readable, well-organized book which impresses the reader with its completeness. American writers are quoted freely and many of their names appear in a very comprehensive bibliography taken from the world's literature.

The treatise is divided into the following parts: anatomy, physiology and pharmacology, physical examination, proctosigmoidoscopy, laboratory examination of the feces, diagnosis by roentgen ray, general methods of treatment, diagnosis and treatment of diseases of the colon, and diagnosis and treatment of the diseases of the anus and rectum. Methods of rectal examination are described in detail and virtues of the authors' "deplicoptic" proctosigmoidoscope are extolled. This instrument has a very small caliber, is equipped with a removal optical and illuminating system and allows the injection of air or water into the bowel. The section devoted to roentgen studies of the colon with the aid of the contrast enema covers 135 pages of the book. The method is called irrigoscopy and in many places the terminology becomes a bit unfamiliar to the American reader. However, the reproductions of roentgenograms are unusually good and their perfection indicates the use of an excellent roentgenographic technique. Both physiological and pathological conditions are considered and little can be said in a critical way other than to express some regret over the small amount of space devoted to the use of the double contrast enema which has become so popular in this country. In many instances short case histories are used to emphasize the value of the roentgenographic findings.

In the clinical sections many tables summarizing signs, symptoms and findings should be of the utmost value to the student interested in the differential diagnosis of colonic diseases. The reviewer, who is not a gastroenterologist, is in no way competent to discuss the therapeutic suggestions which appear in great profusion and seem quite comprehensive. Although all of the illustrations are of excellent quality a series of nine colored plates portray-

ing the proctoscopic appearances of the rectal walls in 36 different abnormal conditions constitutes the most striking feature of the book. The color values are very accurate and no better introduction to the diagnostic use of the proctoscope can be imagined.

The volume contains little that is new. A well-illustrated chapter on radiation injuries, their treatment and prevention would have doubled its value for radiologists. However, it is one of the best available standard textbooks on diseases of the large bowel and it can be freely recommended to the roentgenologist interested in the gastrointestinal tract.

Charles L. Martin

The Therapeutic Problem in Bowel Obstructions: A Physiological and Clinical Consideration. By Owen H. Wangensteen, B.A., M.D., Ph.D., Professor of Surgery of the University of Minnesota and Surgeon-in-Chief of the University of Minnesota Hospital. Cloth. Price, $6.00. Pp. 360, with 90 illustrations. Springfield, Illinois; Charles C Thomas, 1937.

This publication on the problem of bowel obstruction is the clearest and most lucid one that has appeared in the field of general surgery.

The book is divided into three parts. The first is an essay written from observation of experimental investigation on the subject and which was awarded the Samuel D. Gross Prize. This endeavors to explain the factors involved in distention, viz., gas content of the bowel, manifestations of distention upon the bowel wall and the factor played by absorption. The diagnosis of bowel obstruction is taken up, with a plea for identification of both type and location. The rationale of treatment is then discussed based upon the previously laid down observations.

In Part II the general considerations of the problem are discussed. Diagnostic procedures and the common types of obstruction are dealt with.

In Part III special types of obstruction are taken up and diagnosis and treatment indicated.

The work is most thorough in its content and every source of literature has been covered in its preparation. It represents an exhaustive study of the subject.

In many parts of the book a plea is made for better recognition of bowel obstruction through the use of the roentgen ray. The various techniques are explained with their rationale and should add greatly to our better knowledge and recognition of bowel obstruction and the type we are dealing with in the individual case.

The book is one that should be a "must" in every physician's library. The roentgenologist as well as the surgeon can extract much valuable information from it for his own use. Also it should be read by every internist for it allows him to observe the development of the condition and the necessity for early recognition of it and the institution of rational treatment.

The author has prepared a text which is easily read; the type is large and the whole makeup of the book is excellent, conducive to enjoyable reading.

Harold B. Fenech

Chemistry of the Brain. By Irvine H. Page, A.B. (Chem.), M.D., Hospital of the Rockefeller Institute for Medical Research, New York. Cloth. Price, $7.50. Pp. 444. Springfield, Illinois: Charles C Thomas, 1937.

The author has collected in one volume practically all of importance that is known concerning the chemistry of the brain. This neglected branch of chemistry has only recently begun to be reopened and reinvestigated. The earliest careful work in the field is justly credited to John Lewis William Thudichum, M.D., F.R.C.P., who in 1884 published a classic work entitled "Chemical Constitution of the Brain." Following a brief historical introduction, the book proceeds to a systematic review of the chemistry and metabolism of the brain.

The sterols are considered in a separate chapter. Certain observations have been made indicating that sterol metabolism is altered in some diseases of the central nervous system. Phosphatids constitute a large part of the brain lipids. They are both water and organic solvents, are easily split by enzymes, are highly unsaturated and intimately associated with intermediary lipid metabolism. The exact rôle of the phosphatids in the body and brain economy is not known. However, some interesting facts are available. Loss of large quantities of phosphatid from the brain occurs in general paralysis, brain injury and hemorrhage. Furthermore, lipid metabolism is abnormal in xanthomatosis (Hand-Christian-Schüller's syndrome), Niemann-Pick's disease and Tay-

Sachs' amaurotic family idiocy. In Niemann-Pick's disease the chief lipid deposited is phosphatid (lecithin, cephalin or sphingomyelin), whereas in Gaucher's disease (splenohepatomegaly) kerasin is the lipid deposited in excess.

Separate chapters are devoted to Fatty Acid Metabolism, Carbohydrate Metabolism, Nitrogenous Metabolism, Electrolytes and Gases in the Brain, Physical Chemistry and Enzymes of the Brain.

To date 21 enzymes have been found in brain tissue. Although a little is known of the action of each of these, too little is known of their relation to disease processes of the body or the brain. For example indophenol oxidase is found reduced in quantity in the cerebral tissue in cases of amaurotic family idiocy.

An excellent chapter is devoted to Comparative and Developmental Neurochemistry. Some evidence is given of the chemical differentiation of the brain during growth. Further research in this field may give us valuable knowledge of the chemical nature of the brain in hereditary mental disease.

Additional chapters are devoted to the Metabolism of Brain Tissue; Pathological Gaseous Metabolism; and Diet, Vitamins and Degeneration of the Nervous System.

A special chapter by Dr. J. H. Quastel from the Biochemical Laboratory of the Cardiff City Mental Hospital, Wales, is devoted to Oxidations in the Brain. This is a careful review of the metabolism of brain tissue and the specific effects of certain drugs and narcotics on the metabolism of the brain.

In a final chapter Page considers the problem of the Brain and Thought.

This book is a welcome evidence of a new method of investigating and fathoming some of the problems of nervous and mental disease. It is stimulating, very well written, carefully arranged, and filled with facts valuable to the physiologist, the biologist, the biochemist, the neurologist and the psychiatrist.

S. Bernard Wortis

Allergy: Its Practical Application. By J. A. Rudolph, M.D., Associate Clinician in Charge to the Department of Allergy, Mt. Sinai Hospital; Consultant in Allergy, Cleveland Y.M.C.A. Cloth. Price, $3.00. Pp. 224. Philadelphia: Dorrance & Co., 1937.

The rapidly advancing branches of medical science are creating a definite need for compact, informative texts which will give students and other interested persons—not qualified specialists—a useful background and an appraisal of inherent values. This handy volume, it is said, "is based entirely on questions asked by physicians, students of medicine, nurses and other professional groups interested in allergy." Careful inspection of its content reveals the thorough familiarity of the author with the practical developments of his subject. His text is one which will be exceedingly useful to those for whom it was written.

When an author is engaged in planning so abbreviated a manual as this, his greatest task is of course that of selection—ergo, of elimination. In such matters the judgment of no two allergists would ever be the same. The fact, therefore, that this reviewer wonders why the history of allergy brings conspicuously to the attention of the author only the names of Theobald Smith, von Pirquet, Meltzer and Schloss, is not important. In the second chapter, "A Glossary of Certain Terms Used in Allergy," there are, in this reviewer's opinion, definitely erroneous statements which cannot be so lightly passed over. In the first paragraph of this chapter, the author states in explaining the need for accurate definitions: "Physicians will speak of 'allergy,' 'anaphylaxis,' 'atopy,' 'sensitization,' etc. often without regard for the exact meanings of these words. Since careless use of words usually means careless thinking, it is essential . . . to grasp clearly the exact meanings of the words in the allergist's vocabulary." In spite of his recognition of this fundamental truth, his definitions of *Active Sensitization* and of *Passive Sensitization* are not in accordance with the facts of experimental procedure. Sensitization is due to the *first* dose of antigen or serum, respectively—the second, or "shocking" dose has no part in the sensitizing process. Furthermore, it would be easy to quarrel with his definitions of other words, such as allergy, anaphylaxis, atopy and hypersensitiveness. It is true that the exact connotation in the case of each of these terms is a subject of discussion and difference of opinion. This is true to so great an extent that to be completely lucid one must refer to the history and derivation of the words and to the episode or train of thought leading to their construction, in any such treatise as this. In his final chapter, which deals with the "Immunology of Allergy," the author goes far in clearing up the confusion permitted by his definitions. Following closely the

classification of Coca, he separates, in a succinct and brief discussion, the various manifestations of changed reactivity in a way that would much improve the definitions of his second chapter.

It is unfortunate that these faults, so trivial in many ways, should mar the general excellence of the more practical phases of his treatment of the subject of allergy.

The remainder of Part I deals with classification, pathology, diagnosis, preparation of extracts and ends with an invaluable chapter on the common allergens.

Part II is the section of the book which will be most likely to attract the general practitioner. Here he will find the practical phases of the common clinical varieties of allergy considered in a systematic and effective manner. Symptoms and their treatment and causes of failure in treatment are discussed so as to afford a solid groundwork for the beginner or student.

There is an excellent bibliography citing references from the early days of Bostock (1819) and Blackley (1873) up to 1934. The work is well indexed.

A. Parker Hitchens

BOOKS RECEIVED

X-Rays and Radium in the Treatment of Diseases of the Skin. By George M. MacKee, M.D., Professor of Clinical Dermatology and Director of Department of Dermatology (Skin and Cancer Unit) New York Post-Graduate Medical School and Hospital, Columbia University; Consulting Dermatologist, St. Luke's Hospital, etc. Third edition, thoroughly revised. Cloth. Price, $10.00. Pp. 830, with 308 illustrations. Philadelphia: Lea & Febiger, 1938.

Cutaneous Cancer and Precancer: A Practical Monograph. By George M. MacKee, M.D., Professor of Clinical Dermatology and Syphilology and Director of Skin and Cancer Unit, New York Post-Graduate Medical School and Hospital, Columbia University, and Anthony C. Cipollaro, M.D., Associate in Dermatology, Skin and Cancer Unit, New York Post-Graduate Medical School and Hospital, Columbia University. With a Foreword by Francis Carter Wood, M.D., Cloth. Price, $3.75. Pp. 222, with 232 illustrations. New York: American Journal of Cancer, 1937.

Primary Carcinoma of the Lung. By Edwin J. Simons, M.D., Member of the Staff, St. Gabriel's Hospital, Little Falls, Minn.; Member of the Staff, Lymanhurst Health Center, Minneapolis, Minn., etc. Cloth. Pp. 263, with 30 illustrations and two colored plates. Chicago: The Year Book Publishers, Inc., 1937.

The 1937 Year Book of Radiology. Diagnosis. Edited by Charles A. Waters, M.D., Associate in Roentgenology, John Hopkins University; Assistant Visiting Roentgenologist, Johns Hopkins Hospital. Associate Editor, Whitmer B. Firor, M.D., Assistant in Roentgenology, Johns Hopkins University; Assistant in Roentgenology, Johns Hopkins Hospital. Therapeutics. Edited by Ira I. Kaplan, B.Sc., M.D., Director Division of Cancer, Department of Hospitals, City of New York; Clinical Professor of Surgery, New York University Medical College; Director, Radiation Therapy Department, Bellevue Hospital, New York City, etc. Cloth. Price, $4.50. Pp. 503, with 550 illustrations. Chicago: The Year Book Publishers, Inc., 1937.

Atlas of Skeletal Maturation. By T. Wingate Todd, M.B., Ch.B., Manc.; F.R.C.S., Eng., Henry Willson Payne Professor of Anatomy, Western Reserve University; Chairman, Brush Foundation; Director, Hamann Museum; Director, Developmental Health Inquiry of the Associated Foundations, with the collaboration of colleagues and assistants. Cloth. Price, $7.50. Pp. 201, with 75 illustrations. St. Louis: The C. V. Mosby Company, 1937.

The Rôle of Chemiotaxis in Bone Growth. By A. P. Bertwistle, M.B., Ch.B., F.R.C.S. (Edin.). Cloth. Price, 8/6. Pp. 59, with 32 illustrations. London: Henry Kimpton, 1937.

Der Meniskusschaden: Als klinisches, anatomisch-pathologisches und unfallmedizinisches Problem. Von Priv.-Doz. Dr. Hans Schaer, Oberarzt der chirurgischen Universitätsklinik, Zürich. Paper, price M. 10.—; bound, M. 11.80. Pp. 156, with 55 illustrations. Leipzig: Georg Thieme, 1938.

Studien über hereditäre, multiple Epiphysenstörungen. (*Acta raiol.*, Suppl. XXXIV.) Von S. Ribbing. Paper. Price, Swed. cr. 8.— Pp. 107, with 94 illustrations. Helsingfors: Mercators Tryckeri, 1937.

La hernie postérieure du ménisque intervertébral (hernie nucléaire postérieure) et ses complications nerveuses. Par Pierre Glorieux, Bruges. Paper. Price, 40 fr. Pp. 102, with 98 illustrations. Paris: Masson et Cie, 1937.

Traumatismes du pied et rayons X: Malléoles-astragale-calcanéum-avant-pied. Par Étienne Destot, Lyon. Second edition. Foreword by Dr. Alexis Carrel. Paper. Price, 45 fr. Pp. 292, with 152 illustrations. Paris: Masson et Cie, 1937.

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DEPARTMENT OF TECHNIQUE

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PROTECTION DURING GASTROINTESTINAL ROENTGENOSCOPY

A FIXED AMANUAL PALPATION DEVICE

By JESSE DONALD STARK, A.B., M.D.
NEW YORK CITY

THE indications for palpation during gastrointestinal roentgenoscopy are well known. Carman[4] has stated that palpatory manipulation is a very essential part of the roentgenoscopic procedure and should never be omitted. In addition to the routine examination of mucosal relief and the facilitation in filling the cardiac end of the stomach by upward pressure on the pars media, I have found palpation or pressure most necessary in those cases where spastic phenomena, especially in the region of the pylorus, make it difficult for the duodenal cap to be outlined. To chance delay by too long a wait for relaxation is inconvenient in a busy clinic; prolonged manual palpation is a hazard. Exposure of the hands during roentgenoscopy resulted in the first casualties among the pioneers in roentgenology.[3] Leaded rubber gloves should always be used, but their very nature, i.e., the amount of lead required for protection, results in opacity which obscures the fine details in the examined part. The weight of a sufficiently protective glove causes clumsiness and prevents ease in palpation. Leddy, Cilley and Kirklin[6] state that Carman abandoned the use of lead rubber gloves in 1918, as he thought plain buckskin gloves were sufficient protection against radiation. In spite of the fact that three physicians at that Clinic have used only ordinary leather gloves on their palpating hands and have through the judicious use of small beams and shielding by the screen received no *known* ill-effects, the above authors conclude emphatically that roentgenologists should continue to observe the recommendations of the International Safety Committee. Rehfuss[8] has reviewed the various methods that have been used for palpation. He notes the use of the "distinctor" in Europe in 1917. This is the large, angulated, wooden spoon which is held in the hand of the operator not exposed to the screen. Assmann[1,2] has also mentioned this Holzknecht spoon or "distinctor" which has been used since the early days of roentgenoscopy but has been abandoned of late due to its unwieldiness. Even when used, lead gloves are worn, thus increasing the awkwardness. Holmes and Ruggles[5] suggest a variation of this spoon in a device which consists of a flat board with a rounded tip outlined by a lead wire, carrying a protective shield of lead into which the hand fits. Finally, Rehfuss suggests that for compression a certain amount of diffuse pressure may be obtained by the use of the two handles on either side of the screen. This method, however, cannot direct localized pressure.

After a consideration of the above factors, I have devised a spoon which can be substituted for direct manual pressure and is fixed on the screen to allow free use of both hands for manipulation of the screen, diaphragm and for handing the opaque solution to the patient if no assistant is available. It is not necessary to place either hand in the beam of radiation and protection is therefore increased. A vertical bar is attached at both ends, either by removable clamps or permanently by screws, to the combined grid and screen, the bar being placed at the point of the greatest depth

of the arc of the curved grid. Attached to the center of this bar is a short projecting arm with a spoon upon its distal end, pointing toward the patient (Fig. 1). The overall distance of the palpating arm and the spoon is 5 cm. This distance was chosen from the information compiled by Cilley, Leddy and Kirklin,[7] who found that this

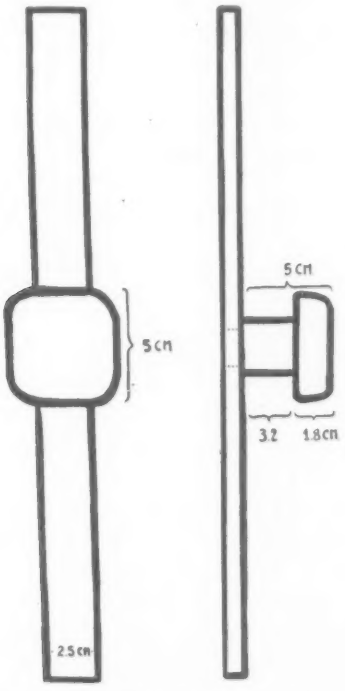

Fig. 1. Plan for the device.

was the average compression distance required to depress the abdominal wall in order to produce visualization of the mucosal relief of the stomach. They found that 8 cm. was required in a large obese man, 3.5 cm. in a small thin woman and 4–6 cm. in the majority of cases. Since more than half of their patients required 5 cm., I chose this length for the arm in order not to lose too much detail on the screen. The vertical bar for attachment is only 0.9 cm. thick and is inconsequential in increasing the distance. Many materials were tried in fashioning this device, but balsa wood was chosen as it is almost completely radiolucent. Its density is 0.096 and its equivalent to 1 mm. lead only 0.0001. In spite of

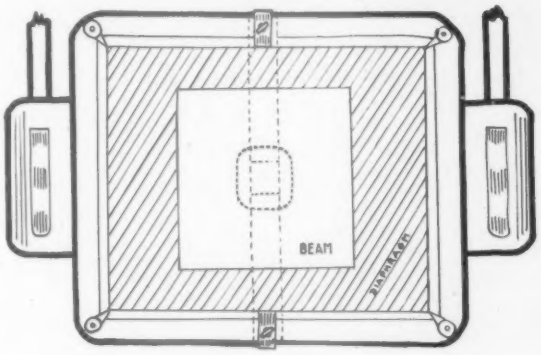

Fig. 2. The amanual spoon is fixed behind the center of the screen and is thus automatically centered in the diaphragmed beam.

its light weight, it is sufficiently tensile for the purpose. The actual spoon is 5 cm. in diameter, 1.8 cm. thick and is partially rounded. During daily use, the examined patients have not found it more uncomfortable than the lead-gloved hand. It is to be noted that, by its placement, the spoon is fixed at the center of the screen and therefore always at the center of the beam, no matter how small the diaphragmed areas may be (Fig. 2). An opaque ring in the spoon has been purposely avoided, so

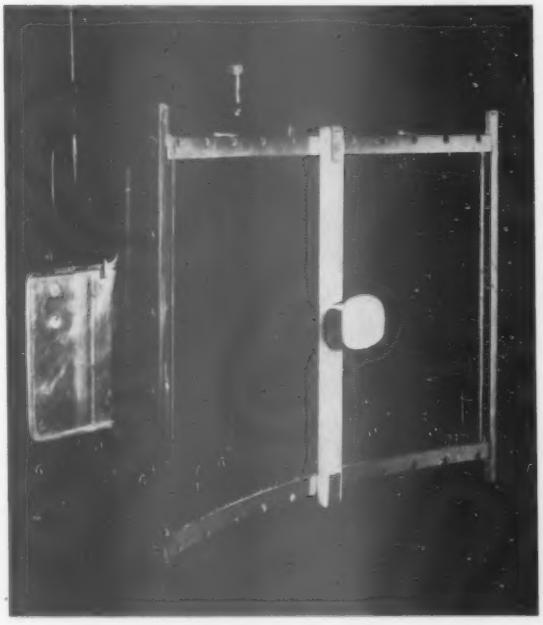

Fig. 3. The amanual spoon attached to the screen and grid.

that no visual interference may be encountered during screening. When palpation is desired, the operator merely presses on the handles of the roentgenoscopic screen. As the spoon moves automatically with the screen (Fig. 3), pressure is centrally exerted in any direction desired. While doing so, the screen-tube distance is not increased by the admission of a gloved hand and detail is not lost. The results of pressure on any examined part may be clearly seen without the interposition of an opaque glove, yet protection is assured.

The advantages of palpation with this fixed device are: (1) The use of a large, detached, unwieldy spoon is obviated. (2) Both hands are free for the manipulation of the screen, etc. (3) The exposure to radiation of a palpating hand is totally removed. (4) The central fixation of the amanual spoon presents it in constant focus within the diaphragmed area, no matter how small, or in what direction the screen is moved. (5) The spoon is radiolucent and does not obscure detail. (6) The device is simply constructed and is inexpensive.

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Vol. 39, No. 3

A PROTECTIVE DENTAL PLATE TO PREVENT UNDESIRED RADIUM REACTIONS OF STRUCTURES ADJACENT TO THE TREATED AREA*

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ALMOST invariably, after the implantation of radium platinum needles for carcinoma of the lower lip, severe radium reaction of the tip of the tongue, the gingivae, and the upper lip occurs. Such reactions, "mucositis," are painful and heal slowly. To overcome this disagreeable complication of an otherwise splendid method, there is suggested a protective plate which shields the adjacent structures from the effects of radiation. In some cases with the use of the plate, complete protection is obtained, while in others, only a negligible amount of reaction is remarked. The plate is comfortable, fits over teeth, if present, and is worn night and day. It is taken out only during mealtime and for oral hygiene. It consists of an appliance into which has been incorporated a piece of lead 2 mm. thick. First, an impression of the patient's lower jaw is taken, and a stone model is made which represents a positive reproduction of the teeth and surrounding tissues. On this model is constructed a vulcanized rubber denture. A curved sheet of lead is faced on the anterior portion. The width, length and shape of the piece of lead depend on the location and size of the tumor. The lead is covered over with the compound and thus the metal is entirely insulated. In addition to the protective interposition of the lead the pushing forward of the lip by the bulk of the appliance increases the distance between the radium implanted in the lip and adjacent structures where radiation is not desired.

FIG. 1. The appliance in place. Radium needles in lip.

FIG. 2. Showing mucositis of tumor. No reaction on tongue or upper lip.

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ABSTRACTS OF ROENTGEN AND RADIUM LITERATURE

ROENTGEN DIAGNOSIS

HEAD

Woodhall, Barnes, and Seeds, Asa E. Cranial venous sinuses; correlation between skull markings and roentgenograms of the occipital bone. *Arch. Surg.*, Nov., 1936, *33*, 867–875.

A preliminary study of 100 consecutive routine roentgenograms of the occipital bones of normal persons, taken in the anteroposterior projection plane, has demonstrated relative differences and variations in the size of the bony markings of the lateral sinuses that closely correspond to the anatomic observations previously reported.

This normal standard of variation, appraised by roentgenographic study, is of clinical value in determining the significance of irregularities obtained by the Queckenstedt test and in determining dynamics of the venous return from the brain in the presence of thrombosis of the lateral sinus or of the jugular vein.—*L. H. Osmond.*

Furlow, Leonard T. Chronic subdural hematoma. *Arch. Surg.*, April, 1936, *32*, 688–708.

Chronic subdural hematoma, reactive or traumatic in type, frequently produces very few localizing signs. The three most important points in diagnosis are: (1) the history of injury; (2) headache, and (3) choked discs. However, the condition may exist in the absence of any or all of these signs. In this series of 16 cases, the shortest latent interval was six days and the longest three years.

Ventriculography or exploratory perforator openings are very often necessary to make the diagnosis.

The surgical treatment of chronic subdural hematoma offers a good prognosis. However, the prognosis is vastly better if the patient comes to the hospital before the development of symptoms of marked cerebral compression. The question of the best surgical approach is not definitely settled. The author prefers the reflection of an osteoplastic flap if the patient is in good condition, and washing out of the contents of the sac through two openings, if the patient is in coma.—*L. H. Osmond.*

Fischel, Eugenio. I fattori determinanti nella patogenesi della epilessia genuina accertati col metodo radiologico. (The determining factors in the pathogenesis of genuine epilepsy as shown by roentgen methods.) *Arch. di radiol.*, Sept.–Dec., 1936, *12*, 329–335.

It is no longer considered justifiable to use the terms essential or genuine epilepsy, because the attack of epilepsy is almost always a late manifestation of some organic change at some period in life, sometimes in intrauterine life. The sequels of these injuries can be detected in the great majority of cases by roentgen examination. Roentgen examination of the skull should never be neglected, particularly in cases in which a careful history does not show signs of any injury that might have caused the epilepsy.

Strict collaboration between the pathological anatomist and the roentgenologist is necessary in this field to show the importance of the changes discovered by roentgen examination in the tables of the skull bones, the meninges and the bones at the base of the skull, and also to determine to what extent inflammations of the brain and meninges in fetal life may cause the changes seen in the adult in the form of malformations of the skull, thickening or calcification of the meninges, premature synostoses, etc.

The changes in size and shape of the sella turcica which are seen so frequently in epilepsy may cause a disturbance of function of the hypophysis resulting in endocrine disequilibrium. Endocrine preparations are indicated in the treatment of epilepsy for the purposes of correcting excess or defect in the function of the hypophysis.—*Audrey G. Morgan.*

NECK AND CHEST

Doig, A. T., and McLaughlin, A. I. G. X ray appearances of the lungs of electric arc welders. *Lancet*, April 4, 1936, *1*, 771–775.

Attention is being directed to the acute pulmonary condition which may occur in welders as the result of their occupation. Metal fume fever and poisoning by nitrous fumes have been described in men working with the electric arc and oxy-acetylene torch. These transient maladies are characterized mainly by malaise, pyrexia and shivering attacks.

Chronic pulmonary lesions directly associated with these occupations have not been recorded previously. The author reports the clinical and roentgen findings in 16 electric arc welders. All are apparently well and working.

All presented pulmonary changes. During welding, dense fumes rise continuously and unless protective measures are adopted the fumes are inhaled. The electrodes are made of a core of metal and an outer covering containing the flux. The fumes consist of the volatilized flux, usually sodium silicate or asbestos, fine particles of iron oxides, nitrogen peroxide and ozone.

The roentgen examinations of the lungs presented a diffuse bilateral mottling not unlike that seen in silicosis. The author considers the asbestos contained in the flux as possibly producing the pulmonary changes but points out the lack of similarity between the roentgen picture of asbestosis and the appearances found in the welders.—*P. J. Hodes.*

Birkelo, C. C., and Kasper, J. A. The circular lesion of pulmonary tuberculosis. *Radiology*, Feb., 1937, *28*, 157–161.

The authors make three groups of the 60 pulmonary cases having circular solid lesions in the lung fields. The first group includes those found to develop from diffuse infiltration. These lesions tend to become smaller and many times there are additional tuberculous foci present. The second group includes those lesions which are definitely circular when first discovered. They tend to remain stationary for months and years. They may excavate and cause a general spread of the disease. The third group includes the receding stage of childhood type of infiltration. These lesions recede without collapse therapy.—*J. H. Harris.*

Gerli, Pietro. Sulla sifilide polmonare. (Syphilis of the lungs.) *Arch. di radiol.*, Sept.–Dec., 1936, *12*, 279–328.

The author describes and illustrates with roentgenograms 4 cases of gummatous syphilis of the lungs. He calls attention to the difficulty of diagnosis of syphilis of the lung both clinically and roentgenologically. In the slow course of gummatous syphilis there is a first stage in which there are only three symptoms: cough, with or without expectoration, fever and pain. There is a second stage in which the physical signs resemble those of neoplasm and a third stage in which the clinical syndrome is that of cavity.

Syphilis of the lung is by no means as rare as is generally supposed.

Gummatous syphilis gives rather characteristic rounded shadows from the size of a pea to that of an orange. Other signs that have some evidential value are the site, in the middle and lower right lobes and the parahilar region, and the presence of stellate perihilar and peribronchial stripes. Even these, however, are found in other conditions and differential diagnosis is quite difficult. In the author's cases the possibility of tuberculosis was discussed.

Diagnosis is still more difficult in chronic syphilitic bronchitis with its diffuse granulomatous infiltration and tendency to sclerosis and its slow course. Diagnosis at as early a stage as possible is extremely important as anti-syphilitic treatment is promptly effective and any other form of treatment is of course worse than useless. Physicians should therefore bear in mind the fact that syphilis of the lungs is by no means rare and use every device of clinical and roentgen examination in the effort to make a differential diagnosis.—*Audrey G. Morgan.*

Scott, Wendell G., Moore, Sherwood, and McCordock, Howard A. Roentgen kymographic studies of cardiac conditions. *Radiology*, Feb., 1937, *28*, 196–210.

The authors report their experience with the kymograph in the study of cardiac disease. They find this method helpful but limited in scope. The films obtained by the device are a record of the physiological motion of the organ or structure examined. In the study of heart disease, the kymogram varies from the normal only so far as the lesion alters the movements of the heart muscle.—*J. H. Harris.*

Hasney, Fred A., and Baum, Felix. Bilateral spontaneous idiopathic pneumothorax in apparently healthy individuals. *Radiology*, Jan., 1937, *28*, 47–54.

The literature of bilateral spontaneous pneumothorax is summarized and one case reported by the authors. They recommend a continuation of the pneumothorax for several weeks or until the roentgenogram shows a thickened visceral pleura which upon re-expansion will remain adherent to the parietal layers.—*J. H. Harris.*

ABDOMEN

YATER, WALLACE M., OTELL, LAWRENCE S., and HUSSEY, HUGH H. Hepatosplenography with stabilized thorium dioxide sol. A follow-up study of 200 patients examined over a period of five years. *Med. Ann. District of Columbia*, August, 1936, *5*, 241–246.

The authors review their experience with the use of a stabilized thorium dioxide sol containing approximately 22 per cent of metal by volume for the purposes of diagnosis in over 200 patients in a five-year period. Immediate reactions due to injection of the solution have been extremely few and quite mild. No immediate reactions have been noted on ordinary observation in the past three years. At present 0.5 cc. of the solution per pound of body weight is employed, one-third of the total dosage being injected on each of three successive days with roentgenograms made on the fourth or following days.

Roentgenograms made even after five years demonstrate that there is still a large amount of the metal present in the body, but there is also definite evidence of some mobilization of it from the reticulo-endothelial cells in which it was originally deposited.

In the authors' experience no contraindications to the injection of the solution have as yet been established. However, its use is not recommended unless more simple methods of diagnosis are unsuccessful.

Of the first 200 patients in whom the procedure was employed, 47 are known to be living and 36 have actually been re-examined both generally and roentgenologically. In the 47 living patients, 26 different diagnoses were made, cirrhosis (Laennec) leading with 10 cases. The time interval following injection in these cases varied between a few months and four years and nine months. In 25 of these patients the bromsulphonphthalein test was performed, 12 patients showing acute or chronic liver disease, only 5 showing retention of the dye at the end of thirty minutes. Eight of these 12 patients are in excellent health subjectively, 3 are partly well and but 1 has progressed to a serious state of hepatic insufficiency clinically.

All of the 134 patients who are dead were suffering from advanced, serious, usually chronic, but in 3 instances, acute liver disease. Most of the patients died within a year.

Roentgenologic re-examinations were made at least once in 47 of the 200 cases. In 20 cases there was relatively little change in the roentgenogram. In 2 cases suspected of being cirrhotic at the original examination, progress films showed definite evidence. In 26 cases definite mobilization or elimination of the solution was shown, appearing as a mottling of the liver or spleen, or both, or by existence of visible lymph nodes either between the liver and the spine or between the spleen and the spine.

Of the entire group the procedure was of value in 150 cases, the diagnosis largely resting upon hepatosplenography in 49 cases. A preliminary histopathologic study of 71 cases indicates that the presence of the solution has not caused appreciable organic changes.—*W. R. Brooksher.*

HAMILTON, JOSEPH G., and STONE, ROBERT S. The intravenous and intraduodenal administration of radio-sodium. *Radiology*, Feb., 1937, *28*, 178–188.

A report is given of the use of radio-sodium parenterally. The authors report that the substance can be given internally to humans without toxic effect in amounts up to 53 "millicuries equivalent." The rate of decay within the body, the proportion eliminated and the concentration of radio-sodium in the body fluids can be directly measured. The quantity of radio-sodium given did not produce observable clinical effects. However, further investigation must be made before definite conclusions can be drawn regarding its therapeutic value.—*J. H. Harris.*

CARTER, RAY A., and LAING, DONALD R. Noncarcinomatous tumors of the stomach. *Radiology*, March, 1937, *28*, 301–314.

The authors discuss in detail the various benign tumors of the stomach and the roentgen findings when these tumors exist. It is an excellent reference article on the subject and one which cannot be shortened to abstract form. An extensive bibliography is given.—*J. H. Harris.*

GLENN, FRANK, and DOUGLAS, EDWARD. Sarcoma of the stomach. *Arch. Surg.*, Sept., 1936, *33*, 476–478.

A case of leiomyosarcoma of the stomach in an advanced stage is described, with full clinical and autopsy reports. When one is confronted with an epigastric tumor, even in the absence of obstruction, without demonstrable filling

defects on roentgen examination and without bleeding into the gastrointestinal tract, it is important to bear in mind the possibility of sarcoma of the stomach, particularly if the patient is in the fourth or fifth decade of life. —*L. H. Osmond.*

Weintraub, Sydney, and Tuggle, Allan. Neoplasms involving the duodenum. *Radiology*, March, 1937, *28*, 362–366.

In 18 proved cases of carcinoma of the duodenum the authors found one or more of the following signs of abnormality present: (1) obstruction of some portion of the duodenum; (2) filling defect of the duodenum; (3) disturbance of the mucosal pattern; (4) pressure defects of the bulb; (5) distortion of the normal duodenal swing; (6) pressure defects on the greater curvature of the duodenum, and (7) air in the bile ducts. A careful study of the mucosal patterns of the entire duodenum as a routine procedure in every gastrointestinal series is recommended.—*J. H. Harris.*

Rowe, Edward W., and Neely, J. Marshall. Primary malignancy of the small intestine. *Radiology*, March, 1937, *28*, 325–338.

The authors briefly review the literature relative to primary malignant tumors of the small intestine and report the findings in 6 cases. They emphasize the importance of careful study of the small intestine if these tumors are to be diagnosed early.—*J. H. Harris.*

Koster, Harry, Kasman, Louis P., and Sheinfeld, William. Regional ileitis. *Arch. Surg.*, May, 1936, *32*, 789–809.

The authors have presented an analysis of their 17 cases of nonspecific inflammatory disease of the ileum and have analyzed the condition in 100 cases reported by others.

Any case in which there are symptoms of inflammatory intra-abdominal disease with peritoneal irritation as well as symptoms of varying degrees of intestinal obstruction must be considered as possibly an instance of regional ileitis. Long-continued duration of symptoms is characteristic in many cases, although clinically the course is short.

The importance of the roentgen findings is stressed, particularly as regards the use of the barium enema. The barium meal may also be used to less advantage, when the lesion is in the terminal ileum. It will be of much greater importance if the lesion is in the upper portion of the intestine. Serial roentgenograms must be studied to establish the diagnosis.

The condition may be subdivided into three types: (*a*) the early lesion, (*b*) the moderately advanced, but not obstructive lesion and (*c*) the advanced stenotic or fistulous process. The early lesion in many instances is spontaneously cured. The therapeutic value of roentgen treatment is a moot question, the number of cases in which it was given being too small to allow of conclusions. A side-tracking operation is probably the method of choice if anything more than conservative treatment seems indicated. In the moderately advanced lesion, the choice of procedure lies between a side-tracking operation and resection. In cases of the advanced stage, resection is indicated.—*L. H. Osmond.*

GYNECOLOGY AND OBSTETRICS

Greenhill, J. P. Hysterography as an aid in the diagnosis of abdominal pregnancy. *J. Am. M. Ass.*, Feb. 22, 1936, *106*, 606–608.

Detailed report is made of a case of abdominal pregnancy, the diagnosis having been made by the injection of iodized oil into the uterine cavity. No harm can result from this procedure if the roentgenogram shows evidence of fetal death and the suspicion of extrauterine pregnancy exists. The method is also desirable in the presence of a dead fetus where the induction of labor has been unsuccessful. With a viable child, together with doubt in the diagnosis, the injection may be dangerous.—*W. R. Brooksher.*

Haffner, Johan. Eineiige Zwillinge mit symmetrischer Wirbelsaulendeformitat. Keilwirbel. (A pair of uniovular twins with symmetrical deformity of the spinal column. Wedge-shaped vertebrae) *Acta radiol.*, 1936, *17*, 529–541.

The author reports the case of a uniovular pair of twin girls twenty years of age. Both showed a scoliosis of the lumbar column convex to the right caused by a wedge-shaped vertebra, in the first sister the 2d and in the other the 3d lumbar vertebra. There was a compensatory scoliosis of the dorsal column to the left. One of the twins also had a 13th pair of ribs and a partial lumbalization of the first sacral vertebra. The existence of this deformity in both of a pair of uniovulvar twins proves that it is hereditary.

While the malformation in these two sisters was the same, the clinical manifestations were very different. One of them suffered intensely from pain in the back and was under treatment for three years, in bed most of the time, while the other experienced very little pain. The pain in the back was probably caused by abnormal muscle action and by arthritic changes in the small joints caused by the scoliosis and torsion. Immobilization and corsets do little good in these cases. The most important thing is to strengthen the muscles of the back, which is best accomplished by orthopedic gymnastics. —*Audrey G. Morgan.*

SKELETAL

Lawrence, W. S., and Anderson, Wm. D. A rare developmental abnormality of the atlas. *Radiology*, Jan., 1937, *28*, 55–57.

The author reports a case in which the posterior portion of the posterior arch of the atlas was separated from the anterior portions of the bone by a space of about half an inch.—*J. H. Harris.*

Morton, S. A. Localized hypertrophic changes in the cervical spine with compression of the spinal cord or of its roots. *J. Bone & Joint Surg.*, Oct., 1936, *18*, 893–898.

The purpose of this paper is to emphasize the occurrence of localized areas of hypertrophic change in the cervical spine, which may occur in such a position as to exert pressure on important nerves. Hypertrophic changes are frequently seen on the anterior and lateral aspects of the vertebral bodies, but their presence on the posterior aspect, where they do encroach on the spinal canal is very uncommon. They do, however, occur in this location, and Morton reports cases with posterior projecting hypertrophic processes which apparently caused symptoms. Hypertrophic changes on the lateral aspects of the bodies in the cervical spine may encroach on the canals for the cervical nerves and cause symptoms. To show these changes most satisfactorily, lateral roentgenograms should be taken in the upright position at a distance of 6 feet. Oblique roentgenograms should be taken to show the canals for the cervical nerves. In interpreting oblique roentgenograms of the cervical spine, it should be remembered that the size of these cervical nerve canals is not constant, they are larger above and diminish in size as they descend. The smallest are those for the sixth and seventh cervical nerves.

These cases are evidently not common, but they do occur, and in cases of obscure pain in the neck or in the arm, the possibility of pressure on the cord or nerves by osteophytes has to be kept in mind. In the literature, case reports have been found of the occurrence of these phenomena in both the dorsal and lumbar spine as well as in the cervical area.—*R. S. Bromer.*

Adams, Carroll O. Multiple epiphyseal anomalies in the hands of a patient with Legg-Perthes' disease. *J. Bone & Joint Surg.*, July, 1937, *19*, 814–816.

The etiology of osteochondritis deformans juvenilis (Legg-Perthes' disease) is not established. The theories to explain its occurrence are not accepted by all. The epiphyseal system in individuals with the disease therefore deserves study and the finding of multiple rare anomalies of epiphyses of such individuals deserves reporting. Adams reports a case of osteochondritis deformans juvenilis in a boy, aged nine. The following anomalies were found in the hands: (1) Double ossification center for the os lunatum, bilateral. (2) Distal epiphysis of first metacarpal with partial fusion to the diaphysis, bilateral. (3) Proximal epiphysis of second metacarpal with beginning fusion to the diaphysis, bilateral. (4) Suggestion of fused proximal epiphysis on fifth metacarpal, bilateral. (5) Distal epiphysis on all the first row of phalanges and on the second to the fifth inclusive of the second row. (6) Growth arrest on the medial side of the distal epiphysis of the second phalanx of the index finger with resultant bowing of the finger, bilateral. The patient was left-handed and the two hands appeared normal, clinically, except for the medial deviation of the distal phalanx of both index fingers.—*R. S. Bromer.*

Lipschultz, Oscar. The end-results of injuries to the epiphyses. *Radiology*, Feb., 1937, *28*, 223–232.

A follow-up study of 380 cases of traumatic epiphyseal separation was made. The most frequent site of such separation was found to be at the lower end of the radius and the next most common was the lower end of the tibia. It was found that premature ossification, with change in growth, takes place frequently after

epiphyseal injury. It occurred in about 14 per cent of cases. The amount of shortening was usually minimal and of no clinical significance. Occasionally a case was noted in which the disturbance in growth was marked with resulting deformity and disturbance in function. This occurs whether or not perfect reduction is obtained and is apparently due to trauma to the epiphysis itself at the time of injury. The author concludes that perfect reduction should be attempted but may not be necessary in the treatment of this type of displacement.—*J. H. Harris.*

ADAMS, Z. B., and DECKER, JOHN J. Unusual locations of tuberculous lesions in the spine. *J. Bone & Joint Surg.*, July, 1937, *19*, 719–724.

The usual site of the destructive lesion of tuberculous origin in the spine is the anterior part of the centrum. Two or three adjacent vertebrae may be simultaneously affected. The process seems to spread up and down under the anterior common ligaments, infecting the centra above and below.

There are certain cases, usually in the low thoracic or lumbar region, in which the disease focus originates in the intervertebral disc and completely destroys the disc and the upper cortical plate of the centrum below and the lower cortical plate of the centrum above. This type occurs both in children and adults, and in children goes on to rapid healing without operation. In adults a fusion at the back is usually done. Occasionally, only the anterior portion of the centrum is decalcified or the process may destroy one side of the centrum, causing a lateral deformity of the spine. In some cases, the lower half of the centrum may be destroyed, and the disc persisting, pushes upward into the softened bone.

The articular joints are very rarely the primary site of the tuberculous lesion. Sometimes small sequestra form within the bodies of the vertebrae. There may be also cavity formation with sequestra. Three cases were observed of tuberculous destruction located in the spinous process. In 4 cases, the lesion was situated between the head of the rib and the vertebral centrum.

Adams and Decker state that the roentgenogram does not always give positive evidence of the tuberculous lesion since at autopsy vertebral centra are often found to be infiltrated completely with tuberculous material when previous roentgenograms gave no evidence of the disease.—*R. S. Bromer.*

MENSOR, MERRILL C. Injuries to the accessory processes of the spinal vertebrae. *J. Bone & Joint Surg.*, April, 1937, *19*, 381–388.

Injuries to the lamina, the articular facets and the pedicles of the vertebrae are only discernible by special roentgenographic studies, made at various angles, and are rarely seen in the routine anteroposterior or lateral views. Mensor believes that these fractures frequently follow torsion injuries and that they give rise to prolonged low-back symptoms. They are usually found in ambulatory patients presenting symptoms of acute low-back disability following torsion injuries. The essential point in the roentgenographic study is to project the articular facets, the pedicles and the lamina in detail, in order that minor abnormalities may be recognized. Stereoscopic studies are of assistance. The roentgenographic technique is simple but time consuming. Patients with these lesions are uncomfortable in oblique positions and require careful immobilization, as roentgenograms with fine focus tubes require a relatively long exposure. The planes of the facets of the vertebral articulations are variable in individuals and in different vertebrae, so that no routine angle of rotation can be given as satisfactory. A trial oblique study at 45 degrees can be used as a base line followed by further studies with either an increase or a decrease in angulation until all of the affected accessory processes are visualized.

Congenital anomalies and failure of ossification must be differentiated from fracture. The common anomalies are seen as defects in the articular facets and failure of fusion of the lamina and the pedicle. Anomalies can be differentiated by their clean-cut line of cleavage, the smooth, rounded character of the bone edges, and the sclerotic changes at the periphery of the fragments. In contrast to these findings, fracture lines are irregular, in variable planes depending upon the lines of force. They frequently show varying amounts of displacement and rotation of fragments when studied stereoscopically. These fractures followed over a given period will disclose evidence of bone regeneration, in many cases progressing to complete healing, whereas congenital anomalies are stationary without visible change over a similar period.

Untreated cases, seen months after the injury, frequently show the fracture ends eburnated and smooth, with evidence of non-union, and having a roentgenographic appearance analogous to a congenital anomaly. In such cases it is often impossible to make a differential diagnosis. The presence of non-union in many cases is the cause of persistent pain. Early diagnosis and the institution of adequate conservative treatment give an excellent prognosis for complete recovery in simple lesions. Injuries resulting in permanent damage to the articular facets may require surgery for their alleviation. —*R. S. Bromer.*

Roberg, O. Theodore, Jr. Spinal deformity following tetanus and its relation to juvenile kyphosis. *J. Bone & Joint Surg.*, July, 1937, *19*, 603–629.

Roberg reviews and describes cases to show that kyphosis of the vertebral column may follow tetanus, with or without demonstrable fracture of the vertebral bodies. The force initiating this deformity is explained on the basis of the contraction of certain muscle groups during tetanic convulsions. Although there is a greater tendency for vertebral fracture to occur in adults, the majority of post-tetanic kyphoses occur in adolescents in an age group corresponding to that of juvenile kyphosis. The similarity to juvenile kyphosis includes also the clinical and roentgenographic characteristics of both conditions, with the exception of the level of the deformity, and this difference is explained by the "dynamic" level of stress in juvenile kyphosis. Post-tetanic spinal deformity in adults is the result of a particularly severe and prolonged attack of tetanus. Because it does not seem possible to explain the occurrence, age incidence, and roentgenographic changes in adolescents purely on the basis of the intensity of tetanic convulsions, and because of the striking resemblance to juvenile kyphosis, a common factor of weakness in certain adolescent spines is sought to explain this. Further study has indicated that this factor, most prominent in juvenile kyphosis, is an overacceleration of endochondral ossification during the period of most active body growth, causing ossification in the metaphyses of the vertebral bodies to lag behind a predominating proliferation of columnar cartilage.

The paper is illustrated with roentgenograms showing the flattening of the vertebral bodies and abnormal indentation of the upper and lower end plates. Fragmentation of the bodies, a line of marked sclerosis or condensation of the spongiosa and occasional fracture are also mentioned as additional roentgenographic findings. The spinal deformity following tetanus assumes the form, in most cases, of a uniformly curved, often rigid kyphos, in the upper or middle thoracic vertebrae; in a limited number of cases a fracture was demonstrated pathologically at this level and in 2 cases there was a compression fracture. In all the cases of the author's series, the patient's physique was almost without exception that of an otherwise normal, healthy individual.—*R. S. Bromer.*

Sashin, David. Relation of pathologic changes of the intervertebral disks to pain in the lower part of the back. *Arch. Surg.*, June, 1936, *32*, 932–944.

Pathologic changes of the intervertebral discs are commonly observed at autopsy. The changes that take place vary from small herniations of the disc through vascular infiltration of the disc substance, fibrous replacement of the elastic tissue, degeneration, and finally shrinkage, narrowing and calcification of the entire disc. As a result, the discs lose their flexibility and resilience. They become firm, immobile and less resistant to the stress and shock of functional activity.

When a disc is narrowed anteriorly, the normal lumbar lordosis is diminished, and the articular facets are slightly separated. When the lumbosacral disc is narrowed, the lumbosacral angle is increased, and there results a considerable separation of the articular facets. As a result of the malalinement of the facets arthritic changes take place, with consequent muscle spasm, pain and often impingement of the fifth lumbar nerve root resulting in sciatic pain down the leg.

Clinically the diagnosis of a narrowed intervertebral space is made from the roentgenograms, especially from the lateral and oblique views.

Seven cases in which there was roentgenographic evidence of a narrowed intervertebral space are reported, and the clinical course is reviewed. Pain in the lower part of the back was a constant complaint. In some cases there was associated sciatic pain down the leg. The treatment consisted in reëstablishing the normal lumbar lordosis under general anesthesia and

supporting the spine by means of a plaster-of-Paris jacket.—*L. H. Osmond.*

Barr, Joseph S. "Sciatica" caused by intervertebral-disc lesions. *J. Bone & Joint Surg.*, April, 1937, *19*, 323–342.

Author's summary and conclusions: A review of the literature reveals that much is known of the normal anatomy and physiology of the intervertebral disc and that, chiefly due to Schmorl's work, the pathological changes which may occur are fairly well elucidated. The entity of posterior prolapse into the spinal canal is of great clinical significance, as it may cause disability and even death from pressure on the cord or on the cauda equina. The lesion known as "chondroma" or "ecchondrosis" of the intervertebral disc is apparently the same as the posterior prolapses.

The cases in which the lesion is in the low lumbar spine may show symptoms and signs indistinguishable from those of sacroiliac or lumbosacral strain and so are seen primarily by the orthopedic surgeons. Unless the specialists in this field are aware of the entity and take the proper steps to arrive at the correct diagnosis, useless orthopedic treatment will be instituted. A careful neurological examination, in addition to the orthopedic examination, is indicated in every case of "low-back strain." If the symptoms remain intractable after adequate conservative treatment, lumbar puncture should be performed and the total protein content of the spinal fluid should be determined. If it is over 50 mg. per 100 cc., the evidence is in favor of an intraspinal lesion rather than mechanical joint or ligamentous strain, and therefore sacroiliac or lumbosacral fusion is contraindicated until cord or root pressure is ruled out by careful lipiodol roentgenographic examination. Even if the total protein is within so-called normal limits, there may be present a ruptured disc which is responsible for the patient's symptoms.

Forty cases of proved rupture of the intervertebral disc into the lumbar spinal canal with involvement of one or more roots of the cauda equina by direct pressure have been reported in this paper. Twelve were in the lumbosacral disc, 26 in the disc between the fourth and fifth lumbar vertebrae, one between the second and third lumbar, and one between the third and fourth lumbar.

There were 35 males and 5 females. The average age was thirty-seven years. A history of trauma was present in 77.5 per cent of the cases.

Pain was the major presenting symptom. Its character was that of the familiar "sciatica," always radiating down the posterior thigh and usually the posterolateral calf. Orthopedic examination revealed the classical signs of low-back strain,—muscle spasm, list, limitation of motion, limitation of straight-leg raising, tender areas, etc. Fixed lumbar kyphosis or an abnormally flat back was present in over half of the cases. Neurological examination revealed definite peripheral sensory changes in 17 cases. There was an absent knee jerk in 50 per cent of the cases. Muscle weakness, paralysis, cramps and loss of urinary and rectal control were less frequent, but they occurred.

Lumbar puncture revealed an elevated total protein in all but 5 cases. The average was 60 to 100 mg. per 100 cc. Roentgenograms showed local hypertrophic changes or disc narrowing in less than half the cases. Lipiodol examination localized the lesion in 36 of the 40 cases.

The end-result study showed one death due to the lesion (paraplegia). There was essentially complete relief from pain in all cases but one. In that one the continued pain seems to be due to other pathology. Sufficient time has not elapsed to permit determination of the amount of permanent disability following the operative removal of a ruptured disc. Our experience indicates that the back is stronger if fusion is combined with the laminectomy.

There seems to be no doubt that a clinical entity with a proved pathological etiology is being removed from the vague classification of lumbosacral and sacroiliac strains. It is not excessively rare and should be thought of in every case of back strain and "sciatica."—*R. S. Bromer.*

Williams, Paul C. Lesions of the lumbosacral spine. Part I. Acute traumatic destruction of the lumbosacral intervertebral disc. *J. Bone & Joint Surg.*, April, 1937, *19*, 343–363.

This paper is a study of 1,000 cases of chronic or recurring pain in the lower part of the back, which, in the majority of cases, radiated down one extremity and occasionally down both extremities. The first portion of the paper consists of a comprehensive study of the intervertebral disc and its component parts, the nucleus pulposus, the annulus fibrosus and the

two cartilaginous plates. The first of these, the nucleus pulposus, furnishes the intervertebral support rather than the second, the annulus. Chronic traumatic compression over a prolonged length of time results in degenerative changes in the disc. The disc between the fifth lumbar and the upper sacral segment is subject to more trauma, both acute and chronic, than any other intervertebral disc.

The principal portion of the paper is devoted to a discussion of acute traumatic destruction of the lumbosacral intervertebral disc. The symptoms and clinical findings vary in this condition with the progressive course of the disease as well as with the severity at the time of the examination. Pain in the back is noticed in the beginning and all spinal motions increase its severity. There is usually tenderness over the lumbosacral junction. At this stage deviation of the spine is uncommon. In recurrent attacks symptoms are usually spread over a larger area. A sciatic scoliosis is a common finding. Extension of the spine increases the severity of the pain. Segmental symptoms develop and the patient complains of pain radiating down the leg. The patient is unable sometimes to straighten up. If the segmental symptoms become chronic there is usually atrophy of the thigh and the calf.

The pathology and treatment of the condition are also discussed. The roentgenographic findings are a narrowing of the lumbosacral disc and a constriction of the lumbosacral foramina. When the articular facets of the first sacral are in the transverse plane, it is not uncommon to find that, in the process of settling, the fifth lumbar vertebra has been displaced slightly backward in its relation to the first sacral segment. Hypertrophic marginal changes and sclerosis about the facets are frequently observed. Also, osteophytic formation around the inferior margin of the fifth lumbar vertebra and the superior margin of the first sacral segment may be apparent in chronic cases.

It is impossible by roentgenographic studies to state definitely in all cases whether the etiological factor concerned in bringing about the destruction of the disc was an acute or chronic injury. However, in a certain percentage of cases, the roentgenogram affords the best means of a differential diagnosis. In cases in which the narrowing of the disc is confined to the lumbosacral spine alone, it is very suggestive of an acute traumatic origin. This is particularly true when an exaggerated lumbar lordosis is present. In such a case, if the trauma has been of a chronic character, the narrowing would not have been confined to the lumbosacral disc alone, but would have involved the other intervertebral discs of the lumbar spine. It is also very suggestive in cases where the patients present a good posture,—that is, where the lordosis is not of a degree severe enough to bring about chronic degenerative changes, yet the roentgenograms show a marked narrowing of the lumbosacral intervertebral disc. After degenerative changes of a postural nature have resulted in a generalized narrowing of the posterior portion of the lumbar intervertebral discs, it is impossible to say whether the more severe settling of the lumbosacral disc is the result of acute or chronic trauma. The narrowing of the disc may include only the posterior half, the anterior portion retaining its normal width; or it may include the entire disc, depending considerably upon the tilt of the sacral table.

A thorough knowledge of both the motor and sensory distributions of the lumbar and sacral nerves is essential in making an intelligent diagnosis in these cases.—*R. S. Bromer.*

Williams, Paul C. Lesions of the lumbosacral spine. Part II. Chronic traumatic (postural) destruction of the lumbosacral intervertebral disc. *J. Bone & Joint Surg.*, July, 1937, *19*, 690–703.

Under the grouping of chronic traumatic (postural) destruction of the lumbosacral disc, the author places all mechanical alterations of the low spine which cause an uneven distribution of weight on the intervertebral discs. This results in an early pathological degeneration of that portion of the disc which is under abnormal stress. Due to the structure of the lumbosacral region and to the erect posture of man, this stress is exerted only on the posterior and lateral margins of the lower spinal discs.

A lateral tilt of the first sacral vertebra, due to a short leg, or to hemiatrophy, or to a congenital malposition of this segment, is the most common cause of increased pressure on the lateral aspects of the lumbosacral disc. A lumbosacral lordosis is the common cause of pressure on the posterior margin of the lower lumbar and lumbosacral intervertebral discs. Posture is undoubtedly responsible for the vast majority of painful backs.

The roentgenographic findings of those patients presenting a pelvic obliquity are a tilt of the sacral table, a narrowing of the lumbosacral joint space, a subluxation of the lumbosacral facets, and frequently hypertrophic lipping and sclerosis involving the facet articulations, and occasionally, the vertebral bodies. The roentgenographic studies of those cases which are due to a lumbosacral lordosis show a narrowing of the posterior margin of the lumbosacral joint space. A similar narrowing of the posterior portion of the intervertebral joint spaces continues throughout the lumbar region. The subluxation of the facets, as well as the hypertrophic lipping and sclerosis, is most marked at the lumbosacral articulation and becomes less apparent as they approach the lumbothoracic spine.

In this paper the etiology, the symptomatology, pathology and treatment are also thoroughly discussed. Postural exercises and a lordosis brace are described. The author concludes that lumbosacral fusion is not a panacea for all low-back troubles. Surgery should never be employed until a thorough conservative program has overcome a fixed lumbosacral lordosis and lengthened the short hip-flexor muscles. If this is not accomplished preoperatively, the patient will be likely to develop symptoms just above the graft a few months after becoming ambulatory. A well-planned conservative program will eliminate the need for surgery in most cases.—*R. S. Bromer.*

Sutro, Charles J. The pubic bones and their symphysis. *Arch. Surg.*, May, 1936, *32*, 823–841.

Clefts in the interpubic tissues are due to degeneration; static forces may be responsible for their occurrence. Pregnancy causes relaxation and stretching of the ligaments and interpubic tissues, accentuating the degenerative processes. In all specimens taken from adults, progressive (normal) degenerative manifestations could be observed.

Roentgenograms of the pubic bones taken from the young demonstrated the serrated appearance of the symphyseal face as normal. After puberty, growth may cause unusual conformation of the pubic face. Certain rare roentgenographic appearances may be noted owing to the presence of cartilaginous herniations or inclusions.

The frequent demonstration of pathologic processes in the series studied emphasizes the importance of clinical and roentgenographic examination of the pubic region, especially on the slightest suspicion of an osseous lesion. When post-mortem examinations are limited in extent, extraction of the pubic bones for study is strongly advised; local and general osseous pathologic changes may thereby be elucidated. —*L. H. Osmond.*

Pich, Gertraude. Histopathologic study in a case of Perthes' disease of traumatic origin. *Arch. Surg.*, Oct., 1936, *33*, 609–629.

The pathologico-anatomic features of the upper epiphysis of the femur, which corresponded in its clinical, roentgenologic and pathologic manifestations to that of Perthes' disease and which followed a definite history of trauma, are presented in minute and complete detail.

All the changes in the head of the femur as seen in the sections may be explained as follows: First, the original trauma led to compression of the spongy bone and to subsequent aseptic necrosis. Fibrous tissue invaded the involved areas in an attempt to resorb the dead bone. This resorption led to diminished resistance of the epiphyseal nucleus. Under certain mechanic stresses, such as weight bearing, this weakening of the bony structure in turn caused secondary traumatic changes in the bony tissue as well as in the joint cartilage, epiphyseal plate and synovial capsule. The partial destruction of the epiphyseal plate led to an early synostosis between the epiphysis and the diaphysis in this area and would certainly have caused disturbance in growth.

The reader is referred to the original article for an excellent histopathologic study in a case of Perthes' disease of traumatic origin.—*L. H. Osmond.*

Rechtman, A. M. Etiology of deep acetabulum and intrapelvic protrusion. *Arch. Surg.*, July, 1936, *33*, 122–137.

The etiology of protrusion of the acetabulum, in the author's opinion, is primarily a congenitally deep acetabulum, which is basically the result of overgrowth of some elements of the acetabulum. The intrapelvic protrusion is secondarily an acquired defect superimposed on congenitally acquired deep acetabulum by virtue of an abnormal strain of dysfunction, due to a deeply seated head, and an altered relation

of the pressure of the pelvifemoral muscles. Disease seems to have little or no effect on the production of this condition.

In the congenitally deep acetabulum, roentgenographic examination shows a cavity that is deeper and larger, and its inner wall is thinner than normal. In intrapelvic protrusion, the head of the femur usually appears elongated because of the vegetative growths on the margins of the head and of the acetabulum, which overhang the neck of the femur. The head of the femur is intact. The protruding inner wall of the acetabulum may be paper thin and is usually sclerotic. The joint space may be normal, widened, or narrowed. Vacuolation is seen at times in the head of the femur and in the trochanter. The angle of the neck with the femur is usually a little smaller than normal.—*L. H. Osmond.*

Sloané, David, and Sloane, Marian F. Acute neisserian intrapelvic protrusion of the acetabulum (Otto pelvis). *J. Bone & Joint Surg.*, July, 1937, *19*, 843–846.

The authors report a case of acute intrapelvic protrusion of the acetabulum in a girl of eighteen years of age. She was observed for a period of one year. Roentgenograms demonstrated the onset and rapid development of the acetabular protrusion and the pathological data pointed to a neisserian origin. The process subsided when ankylosis ensued.

There are two main groups of this condition: (1) the acute, rapidly destructive, infectious type, and (2) the slowly progressive, chronic type which occurs during the course of any disease that weakens the acetabular floor. Many of the acute infectious conditions of the hip joint go on to complete ankylosis. Why Otto's pelvis developed in this case is uncertain. The authors think it quite probable that the acuteness of the process so rapidly weakened the pelvic floor that the head of the femur progressed inwardly before ankylosis took place.—*R. S. Bromer.*

Green, William T., and Shannon, James G. Osteomyelitis of infants; a disease different from osteomyelitis of older children. *Arch. Surg.*, March, 1936, *32*, 462–493.

Ninety-five cases of osteomyelitis in infants (under two years) are reported. It is observed that osteomyelitis of infants differs greatly from osteomyelitis of older children, not only in many clinical features, but in many principles of therapy.

Streptococcic osteomyelitis occurs twice as frequently as staphylococcic osteomyelitis in infants. When associated with respiratory tract infection, osteomyelitis was usually due to *Streptococcus haemolyticus*, occasionally to pneumococcus and rarely to *Staphylococcus aureus*. When associated with cutaneous lesions, the organism was more likely to be *Staphylococcus aureus*.

Sequestration is rare in infants. Roentgen examination frequently reveals marked destruction of the shaft with an extensive involucrum, suggesting that sequestration will occur, but this rarely happens. If the patient survives the acute infection, the prognosis for sound bones is excellent.

In treatment, the care of the patient rather than the osteomyelitis is the important consideration. Surgical intervention at an early period in the disease is not essential. If operation is performed on the bone, it should not be extensive. Adequate drainage of the fluctuant abscess in infants, without operation on the bone, seems to give as satisfactory results as a more extensive procedure. The part should be immobilized until the wound has healed and there is healing evident on the roentgenogram.—*L. H. Osmond.*

Kling, David H. Arthritis and injuries to joints. *Arch. Surg.*, August, 1936, *33*, 213–224.

Single severe injuries to the joints as well as mild repeated trauma are important factors in the etiology of arthritis. The lesion and the irritation of the soft tissues and the bone produce inflammatory reactions which lead to hypersecretion and hypertrophy of the membrane and to deformation of the articular surfaces.

The frequent affection of articular cartilage by trauma leads to degeneration and erosion and may provoke the development of osteoarthritis. Trauma not only presents the first link in the chain of pathologic changes in unspecific osteoarthritis but may open a path for the invasion of the joint by nonspecific organisms as well as by the tubercle bacillus and *Spirochaeta pallida.*

The examination of joint effusions is an important means of determination of the severity of an injury and of differentiation between traumatic and inflammatory effusions and be-

tween specific and nonspecific conditions of joints. The icteric index of traumatic effusions is above 5; that of inflammatory effusions is invariably below 5. The aspiration of the joint evacuates pathologic products from the joint cavity and reduces irritation and thus promotes the restoration of normal conditions.

Requirements for the prevention of arthritis after injuries of joints or in the vicinity of joints are reduction of fractures, early removal of loose or lacerated cartilage and repair of ligaments. Proper therapy, with rest, fixation of the fracture and resumption of motion, is of the utmost importance; it requires thorough understanding of the physiology and pathology of joints, and great clinical experience. The early recognition of constitutional or acquired anomalies and diseases which are apt to traumatize or invade the joints, such as osteochondritis dissecans, Perthes' disease, genu valgum and genu varum, syphilis, tuberculosis and endocrine disturbances, opens a way for preventive measures to reduce the development of chronic arthritis.

The author makes a plea to restore to the joint priority in the consideration of the problems of arthritis, but he does not intend to minimize extra-articular factors.—*L. H. Osmond.*

Freund, Ernst. Unusual cartilaginous tumor formation of the skeleton. *Arch. Surg.*, Dec., 1936, *33*, 1054–1077.

The purpose of this article is to report a few cases of cartilaginous tumors of the skeleton, which represent in part unusual forms of otherwise well-known conditions, and in part an apparently rare form of a multiple intra-articular tumor formation which, to the author's knowledge, has not been previously described in the literature.

A case of an embryonal enchondroma in the upper third of the femur in a man aged fifty-five presents evidence of growth in recent years. Roentgen therapy was instituted. During two years' observation and frequent control examinations, no increase in the size of the lesion could be noted.

An osteochondroma of the os calcis is unusual only so far as it showed many nodular cartilaginous prominences on the surface.

A case of multiple cartilaginous exostoses in a man, aged twenty-three, shows several features which are not typical. In this case there was a relatively late onset of symptoms with increasing severity a long time after the full skeletal growth had been reached. There was also a pronounced participation of the great joints due to enlargement of the bones close to the joints. The exostoses tended to involve the entire circumference of the affected bony portion, thus leading more to a picture of a diffuse hyperostosis than to that of cartilaginous exostoses.

The most valuable case is that of a man, aged twenty-six, presenting multiple tumors of joints which the author, after thorough and careful analysis, presents as the first case report of true intra-articular osteochondromata. The author says that on the basis of a hyperactive enchondral ossification of joint cartilage, true lengthening of an extremity occurred and marginal exostoses developed as simple hyperplastic formations. In a few places, the hyperplastic process went farther, to true tumor formation, resulting in huge intra-articular osteochondromata.—*L. H. Osmond.*

Francisco, C. B., Pusitz, M. E., and Gerundo, Michele. Malignant degeneration of a benign bone cyst? *Arch. Surg.*, April, 1936, *32*, 669–678.

A completely studied case is presented in which a chondrosarcoma arose at the site of a former bone cyst.

The diagnosis of a benign bone cyst was made at the age of nine months and patient was discharged at the age of six years as cured. At nine years of age an undisputed diagnosis of chondrosarcoma was made.

There are two rare features: First, the fact that the formation of cysts began when the patient first started to walk, and second, the malignant degeneration of the cyst.—*L. H. Osmond.*